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Report of the Eighteenth Annual Forest Pest Control Forum

Government Conference Centre, Ottawa, Ontario

November 20–22, 1990

Rapport du dix-huitième colloque annuel sur la répression des ravageurs forestiers

Centre des conférences du Gouvernement, Ottawa (Ontario)

Du 20 au 22 novembre 1990

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The Forest Pest Control Forum is held under the aegis of Forestry Canada to provide the opportunity for representatives of provincial and federal governments and private agencies to review and discuss forest pest control operations in Canada and related research.

Le colloque sur la répression des ravageurs forestiers se déroule sous l'égide de Forêts Canada dans le but de donner l'opportunité aux représentants des gouvernements fédéral et provinciaux ainsi qu'aux organismes privés de passer en revue et de discuter les activités relatives à la répression des ravageurs forestiers, de même que la recherche connexe.

B.H. Moody
Forestry Canada / Forêts Canada
Ottawa, Ontario / Ottawa (Ontario)
May 1991 / mai 1991

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United States Forest Service
Dan R. Kucera, Broomall, PA

Newfoundland Department of Forest Resources and Lands
H. Crummey, St. John's

Nova Scotia Department of Lands and Forests
Eric Georgeson, Truro

New Brunswick Department of Natural Resources
N.E. Carter, Fredericton

New Brunswick Department of Environment
Wendy Sexsmith, Fredericton

Ontario Ministry of Natural Resources
C. Howard, Sault Ste. Marie
G. Munro, Sault Ste. Marie
Tom Donaghy, Tweed
Cindy Krishka, Tweed

Department of Natural Resources Manitoba
R. Westwood, Winnipeg

Alberta Forestry, Lands and Wildlife
H. Ono

J.D. Irving Limited
B. Brunsdon, Saint John
D. Oxley, Saint John

Canadian Pulp and Paper Association
Jean-Pierre Martel, Montreal

Syndicat Producteur Debois BSL
D. Landry

SOPFIM
G. Déry, Quebec

N.B. Forest Protection Ltd.
D. Davis

Lavalin Environment
Marie-France Sottile, Montreal

Department of Fisheries and Oceans
Barry Hobden, Winnipeg

Environment Canada
Ian Nicholson, Pesticides Division, Ottawa

Canadian Wildlife Service
Peter A. Pearce, Fredericton
Céline Boutin, Hull

Federal Pesticide Registration Review
G. Leblond

Agriculture Canada
D. Walter, Plant Health Division, Ottawa
H. Krehm, Plant Health Division, Ottawa
Rosalyn McNeil, Plant Health Division, Ottawa
T. Kuchnicki, Plant Health Division, Ottawa
J.A. Garland, Plant Health Division, Ottawa
R.G. Taylor, Pesticides Directorate, Ottawa
J.E. Irvin, Pesticides Directorate, Ottawa
L. Doliner, Pesticides Directorate, Ottawa
A. MacDonald, Pesticides Directorate, Ottawa
H. Thompson, Pesticides Directorate, Ottawa
Al Schmidt, Biosystematics, Ottawa

Forestry Canada
G.A. Van Sickle, Victoria
R.F. Shepherd, Victoria
H. Cerezke, Edmonton
L. Magasi, Fredericton
P.C. Nigam, Fredericton
E. Kettela, Fredericton (chairperson)
A. Juneau, Ste. Foy
D. Lachance, Ste. Foy
C. Hébert, Ste. Foy
G.M. Howse, Sault Ste. Marie
J. Meating, Sault Ste. Marie
B.V. Helson, Sault Ste. Marie
E.S. Kondo, Sault Ste. Marie (chairperson)
John Cunningham, Sault Ste. Marie
E.T. Caldwell, Sault Ste. Marie (chairperson)
K.M.S. Sundaram, Sault Ste. Marie

B.L. Cadogan, Sault Ste. Marie
Gary Grant, Sault Ste. Marie
C. Nystrom, Sault Ste. Marie
B. Zylstra, Sault Ste. Marie
S. D'Eon, PNFI
A. Raske, St. John's
Leo Clark, St. John's
Les Carlson, Ottawa
Peter Hall, Ottawa
B. Haddon, Ottawa
P. Singh, Ottawa
G. Steneker, Ottawa
John Cunningham, Sault Ste. Marie
J.C. Mercier, Ottawa
F.C. Pollett, Ottawa (chairperson)
B.H. Moody, Ottawa (secretary)

NOTICE OF 1991 MEETING

The Nineteenth Annual Forest Pest Control Forum
will be held in
Sussex Room, 1st Floor
Government Conference Centre
2 Rideau Street, Ottawa
November 19, 20, 21, 1991
(8:30 a.m. - 4:00 p.m.)

Avis de la réunion de 1991

Le dix-neuvième colloque annuel
sur la répression des ravageurs forestiers
aura lieu dans le
Salon Sussex, 1^{e} étage
Centre de conférence du Gouvernement
2, rue Rideau, Ottawa
du 19, 20, 21 novembre 1991
(de 8:30 h à 16:00 h)

Agenda

Eighteenth Annual Forest Pest Control Forum

Government of Canada Conference Centre
2 Rideau Street
Centennial Room, 5th Floor
Ottawa, Ontario

November 20, 21, 22, 1990
8:30 a.m. - 5:00 p.m.

Tuesday, November 20

Session I - Chairperson - F.C. Pollett, Forestry Canada, Director General, Science Directorate

8:30 - 9:00 1.1 Introductory Address - J.C. Mercier, Forestry Canada Deputy Minister

1.2 Remarks and Introductions - B. Moody, Forum Secretary

1.3 Update on Green Plan - Implications for Pest Control - F.C. Pollett

Session II - Forest Insect and Disease Status and Control Operation Summaries - B. Moody/E. Kettela (Session Chairpersons)

9:00 - 10:00 This Session will consist of round-the-table summary reports from each regional FIDS head on all pests of significance and control operation summaries from provincial representatives./ Presenters should limit their talks to max. of 15 minutes.

	FIDS Report	Control Operation Summary
2.1	Newfoundland- A. Raske	H. Crummey - Newfoundland
2.2	Maritimes - L. Magasi	N. Carter - New Brunswick D. Davis - New Brunswick E. Georgeson - Nova Scotia L. Magasi - P.E.I.
2.3	Québec - D. Lachance	M. Auger - Québec L. Dorais - Québec A. Juneau - Québec

2.4	Ontario - G. Howse	G. Munro - Ontario C. Howard - Ontario J. Churcher - Ontario
2.5	Prairies - H. Cerezke and Northwest Territories	R. Westwood - Manitoba - Saskatchewan - Alberta
	FIDS Report	Control Operation Summary
2.6	B.C. - G. Van Sickle and Yukon	G. Van Sickle for B. Deboo - B.C.
2.7	United States - D. Kucera, H. Trial (Report Only)	

10:00 - 10:15 Coffee

10:15 - 12:00 Session II Continues

12:00 - 1:00 Lunch

1:00 - 3:00 Session II Continues

3:00 - 3:15 Coffee

Session III -

3:15 - 4:00 - Vegetation Management Summaries
- E. Caldwell (Session Chairperson)

3.1 Report from Canadian Forest Nursery Weed Management Association - L. Lanteigne

3.2 Report from Canadian Vegetation Management Association - P. Reynolds

3.3 Round-the-table regional summaries of vegetation management problems and control operations - provincial and regional Forestry Canada representatives British Columbia, Prairies, Ontario, Quebec, Maritimes, Newfoundland, United States

3.4 General Discussion

Session IV -

4:00 - 5:00	Issues Debate, Chairperson - G. Munro
3.1	Report on progress for 1989 recommendations
3.2	Discussion and debate on selected items NOTE: Forum members should ensure that issues/recommendations for debate are properly documented and submitted to the Forum Secretary before the Forum so that these can be discussed at the Steering Committee meeting the day prior to the Forum.

Wednesday, November 21

Session V -

8:30 - 10:00	Regulatory Considerations - Errol Caldwell (Session Chairperson)
5.1	Update on Registration Review Process - G. Leblond/J.P. Martel
5.2	Minor Use of Pesticides Program - Forestry Submission - R. McNeil/H. Krehm
5.3	Forest Pest Management Caucus Update - J.P. Martel
5.4	CPPA Activity Update - J.P. Martel
5.5	Pesticides Directorate - Regulatory Session (R. Lidstone, A. Macdonald, J. Byrne, D. Rothwell, J. Irvin) a) Minor Use b) Fenitrothion Review c) Velpar d) Genetically Modified Organisms e) Microbial Registrations and Efficacy Guidelines
10:00 - 10:15	Coffee

Session VI -

10:15 - 11:00 Research, Environmental Monitoring and Other Reports - E. Kondo (Session Chairperson)

6.1 FPMI Strategic directions - Ed Kondo

6.2 Summary of FPMI and Forest Sector major initiatives - Errol Caldwell

6.3 Efficacy of Dipel 352 vs spruce budworm - Leo Cadogan

6.4 An Elisa method to study the distribution and persistence of B.t. toxin in a forest environment - Somu Sundaram

6.5 Spray trials with Disparvirus in Simcoe District, Ontario - John Cunningham

6.6 Droplet Distribution and Efficacy Against Spruce Budworm Larvae of Undiluted DIPEL^{R} Formulations using Micyonair AU4000 - P.C. Nigam

12:00 - 1:00 Lunch

1:00 - 3:00 Session VI Research, etc. continues

6.7 Insecticide MK 243 - B. Helson

6.8 The Manitoba integrated Dutch Elm Disease Program - A.R. Westwood

6.9 Experimental Spray Against Black Army Cutworm - R. West

6.10 Hemlock Looper Management Decision Support Systems - A. Raske

6.11 Progress Report on forest insect control with entomopathogenic nematodes against spruce budmoth, seedling debarking weevil and nursery insects - Sandra Zervos/D. Eidt

6.12 Other Research Papers

Environmental Research and Monitoring

6.13 Round-the-table monitoring reports, specific environmental research projects and reports relating to environmental concerns of forest pest management practices are to be covered here

3:00 - 3:15	Coffee
3:15 - 4:00	Session VI Research, Monitoring, etc. continues
4:00 -	Session III Issues Debate continues - G. Munro

WORKSHOPS

Monday, November 19, Conference Centre, 2 Rideau Street

- Committee for Review and Improvement of Survey Assessment Techniques - CRISAT - M. Auger (Chairperson) 9 AM
- Pheromone Trapping Working Group - G. Grant (Chairperson) 1:00 PM
- Pest Control Forum Steering Committee - B. Moody/G. Munro (Chairpersons) 3:00 - 5:00 PM

Thursday, November 22, Conference Centre, 2 Rideau Street

- Environmental Monitoring Committee Eastern Spruce Budworm Council S. Homes (Chairperson) 9:00 AM
- 1990 B.t. Spray Results - G. Munro (Chairperson) - 9:00 AM
- Development of Protocols Guidelines for testing of aerially applied pest control agents for forest pest - J. Irvin (Chairperson) - 1:00 - 4:00 PM
- FIDS Heads Meeting to start immediately after B.t. workshop. (A Wednesday night FIDS Heads Meeting may be scheduled to complete FIDS Agenda)

Friday, November 23, Conference Centre, 2 Rideau Street

- FIDS Heads Meeting (closed session) - B. Moody (Chairperson) - 8:30 AM - 5:00 PM

NOTE: 1) Other workshops can be scheduled for Thursday, November 22 if required. Please inform the Secretary of requirements.

2) Please bring Vegetation Management Summaries

3) There will be several written reports contributed by other professions from FPMI.

Ordre du jour

XVIII^{e} Forum annuel sur la répression des ravageurs forestiers

Centre des conférences
2, rue Rideau
Pièce du Centenaire, 5^{e} étage
Ottawa, Ontario

Les 20, 21 et 22 novembre 1990
8 h 30 à 17 h

Mardi le 20 novembre

Séance I - Président - F.C. Pollett, Forêts Canada, Directeur général, Direction générales des sciences

8 h 30 - 9 h

1.1 Allocution d'ouverture - J.C. Mercier, sous-ministre, Forêts Canada

1.2 Remarques et Introduction - B. Moody, secrétaire du Forum

1.3 Mise à jour sur le Plan vert - ses incidences sur la répression des ravageurs - F.C. Pollett

Séance II État des populations d'insectes et des maladies des arbres et résumés des opérations de lutte - B. Moody/ E. Kettela (présidents de la séance)

9 h à 10 h

Cette séance est une table ronde où chaque chef régional du RIMA présentera un rapport récapitulatif sur l'ensemble des ravageurs d'importance et où les représentants des provinces résumeront les activités de lutte menées sur leur territoire. / Chaque participant devra limiter sa présentation à un maximum de 15 minutes.

	Rapport du RIMA	Résumé des opérations de lutte
2.1	Terre-Neuve - A. Raske	H. Crummey - Terre-Neuve
2.2	Maritimes - L. Magasi	N. Carter - Nouveau-Brunswick D. Davis - Nouveau-Brunswick E. Georgeson - Nouvelle-Écosse L. Magasi - Î.-P.-É.

2.3	Québec - D. Lachance	M. Auger - Québec L. Dorais - Québec A. Juneau - Québec
2.4	Ontario - G. Howse	G. Munro - Ontario C. Howard - Ontario J. Churcher - Ontario
2.5	Prairies - H. Cerezke et Territoires du Nord-Ouest	R. Westwood - Manitoba - Saskatchewan - Alberta
2.6	C.-B. - G. Van Sickle et Yukon	G. Van Sickle au nom de E. Deboo - C.-B.
2.7	États-Unis - D. Kucera, H. Trial (rapport uniquement)	

10 h à 10 h 15	Pause-café
10 h 15 à 12 h	Suite de la séance II
12 h à 13 h	Déjeûner
13 h à 15 h	Suite de la séance II
15 h à 15 h 15	Pause-café

Séance III

15 h 15 à 16 h Résumé sur les activités de gestion des végétaux
- E. Caldwell (président de la séance)

3.1 Rapport de l'Association canadienne de gestion de la végétation indésirable dans les pépinières forestières - L. Lanteigne

3.2 Rapport de l'Association canadienne de gestion des végétaux - P. Reynolds

3.3 Résumés régionaux des problèmes de gestion des végétaux et des opérations de lutte - réprésentants des provinces et de Forêts Canada de la Colombie-Britannique, des Prairies, de l'Ontario, du Québec, des Maritimes, de Terre-Neuve ainsi que des États-Unis

3.4 Discussion générale

Séance IV

16 h à 17 h Débats sur certaines grandes questions, président - G. Munro

4.1 Rapport sur les progrès accomplis à l'égard des recommandations de 1989

4.2 Discussions et débats sur certaines questions
NOTE : Les participants au Forum doivent s'assurer que les questions/les recommandations à examiner sont accompagnées d'une documentation adéquate et ont été présentées préalablement au secrétaire du Forum afin qu'elles puissent être examinées lors de la réunion du Comité directeur la journée précédant la tenue du Forum.

Mercredi le 21 novembre

Séance V

8 h 30 à 10 h Considérations sur la réglementation - Errol Caldwell (président de la séance)

5.1 Mise à jour sur le processus d'examen de l'homologation des pesticides - G. Leblond/J.F. Martel

5.2 Programme des pesticides à emploi limité - demande du secteur des forêts - R. McNeil/H. Krehm

5.3 Mise à jour sur les activités du Comité de répression des ravageurs forestiers - J.P. Martel

5.4 Mise à jour sur les activités de l'ACPPP - J.P. Martel

5.5 Direction des pesticides - séance sur la réglementation (R. Lindstone, A. Macdonald, J. Byrne, D. Rothwell, J. Irvin)

a) Emploi limité
b) Compte rendu sur le fenitrothion
c) Velpar
d) Organismes génétiquement modifiés
e) Homologation des agents microbiens et lignes directrices sur leur efficacité

10 h à 10 h 15 Pause-café

Séance VI

10 h 15 à 11 h Rapports sur les activités de recherche, la surveillance environnementale et autres sujets - E. Kondo (président de la séance)

6.1 Orientations stratégiques de l'IRRF - Ed Kondo

6.2 Résumé des principales activités de l'IRRF et du secteur des forêts - Errol Caldwell

6.3 Efficacité du Dipel 352 pour lutter contre la tordeuse des bourgeons de l'épinette - Leo Cadogan

6.4 Une méthode Elisa pour étudier la répartition et la persistance de la toxine du B.t. en milieu forestier - Somu Sundaram

6.5 Pulvérisations expérimentales au Dispavirus dans le district de Simcoe en Ontario - John Cunningham

6.6 Distribution des gouttelettes et efficacité des formulations de DIPEL^{R} non diluées appliquées à l'aide du Micronair AU400 pour lutter contre les larves de la tordeuse des bourgeons de l'épinette - P.C. Nigam

12 h à 13 h Déjeûner

13 h à 15 h Suite de la séance VI

6.7 L'insecticide MK 243 - B. Helson

6.8 Le programme intégré de lutte contre la maladie hollandaise de l'orme du Manitoba - A.R. Westwood

6.9 Pulvérisation expérimentale contre la légionnaire noire - R. West

6.10 Systèmes de soutien à la prise de décisions sur la répression de l'arpenteuse de la pruche - A. Raske

6.11 Rapport sur l'état d'avancement des activités de lutte contre la tordeuse des bourgeons de l'épinette, le charançon de l'écorce et les ravageurs des pépinières à l'aide de nématodes entomopathogènes - Sandra Zervos/D. Eidt

6.12 Autres rapports de recherche

Recherche et surveillance environnementales

6.13 Tous les participants à la séance pourront présenter leurs rapports de surveillance, des projets particuliers de recherche sur l'environnement et des rapports relatifs aux préoccupations environnementales soulevées par les méthodes de répression des ravageurs forestiers.

15 h à 15 h 15 Pause-café

15 h 15 à 16 h Suite de la séance VI

16 h Suite de la séance IV - Débats sur certaines grandes questions - G. Munro

ATELIER

Lundi, le 19 novembre, Centre des conférences, 2, rue Rideau

- Comité d'examen et d'amélioration des techniques d'évaluation des relevés - M. Auger (président) 9 h
- Groupe de travail sur les pièges à phéromone - G. Grant (président) 13 h
- Comité directeur du Forum sur la répression des ravageurs forestiers - B. Moody/G. Munro (présidents) 15 h 17 h

Jeudi, le 22 novembre, Centre des conférences, 2, rue Rideau

- Comité de surveillance environnementale, Conseil de l'Est de la tordeuse des bourgeons de l'épinette - S. Homes (président) 9 h
- Résultats du programme de 1990 de pulvérisations de B.t. - G. Munro (président) 9 h
- Élaboration de lignes directrices sur les protocoles d'essai des agents de lutte contre les ravageurs forestiers appliquées par voie aérienne - J. Irvin (présidente) - 13 h à 16 h
- La réunion des chefs du RIMA débutera tout de suite après l'atelier sur le B.t. (La réunion pourra se poursuivre jeudi soir si les chefs du RIMA ne réussissent à examiner tous les points à l'ordre du jour)

Vendredi, le 23 novembre, Centre des conférences, 2, rue Rideau

- Réunion des chefs du RIMA (à huis clos) - B. Moody (président) - 8 h 30 à 17 h

NOTES

1) D'autres ateliers peuvent être ajoutés au besoin au calendrier de jeudi le 22 novembre. Prière d'informer le secrétaire de vos besoins

2) Prière d'apporter vos résumés sur les activités de gestion des végétaux

3) D'autres professionnels de l'IRRF présenteront plusieurs rapports écrits

Summary of Opening Remarks

Eighteenth Annual Forest Pest Control Forum
November 20, 1990, 8:30 a.m.
Centennial Room, 5th Floor
Government Conference Centre, 2 Rideau Street

On behalf of Forestry Canada, I would like to welcome you to this 18th Annual Forest Pest Forum. Since I spoke to you last November, several significant things have happened that relate to the forum. Dr. George Green, a faithful attendee and strong supporter of the Pest Forum, retired on April 21. Dr. Ed Kondo, formerly director, Biorational Control Agents, FPMI, was appointed director general of the institute. I am sure Ed will continue to support the forum as vigorously as George did. A symposium on "Recent Advances in Pest Management" was held in Sault Ste. Marie in October this year. It included plenary and workshop sessions on weed and insect management. A proceedings of papers presented will be available shortly.

This forum also relates closely to the mandate of the new Department of Forestry which is to:

- provide national leadership in the development and coordination of forest policy and programs;
- conduct and foster research and development in the forest sector; and
- work closely with industry and with provincial and territorial governments in forest management and protection.

The new department's mission is to "promote the sustainable development and competitiveness of Canada's forest sector for the well-being of present and future generations of Canadians." Sustainable development is a cornerstone of Forestry Canada's strategic plan and the direction that the department will take in its research and development activities. Protection of our forest resource against damaging insects, diseases, competing vegetation, and other pests is essential to sustainable development. Losses from forest pests is estimated at two-thirds of the total annual harvest.

Methods used in the management of pests must be consistent with federal government and public desires to preserve the environmental quality and ecological integrity of our diverse forest resource. Thus, Forestry Canada, through research and development programs and technology transfer, will give priority to development of integrated forest pest management practices to encourage environmentally acceptable, and economically viable pest management strategies.

Integrated Forest Pest Management (IFPM) is a key component of integrated forest management. Its principles can be used to manage pest populations of destructive insects, tree diseases, and competing vegetation. IFPM provides an ecological approach to reducing pest damage to economically acceptable levels through knowledgeable, integrated use of a variety of pest management options including predators, parasites, pathogens, pest biology, population dynamics, genetically resistant tree species, silvicultural practices, natural control agents, and, as a last resort, appropriate use of synthetic pesticides. IFPM is not a new concept but has not been applied as a complete package in Forest Pest Management in Canada. The approach has been applied in bits and pieces for the management of spruce budworm, mountain pine beetle, gypsy moth, dwarf mistletoes, and root disease.

Development of IFPM tools is a key component of Forestry Canada's research priorities in the proposed Green Plan initiatives and in the pesticides regulation review team recommendations. The Green Plan initiatives include the pursuit of integrated pest management and the carrying out of bio-monitoring programs (to be discussed later in the Forum Agenda). Forestry Canada is a world leader in bio-monitoring, with FIDS and ARNEWS (Acid Rain National Early Warning System). Many countries have asked for assistance in implementing similar networks.

Increased public involvement, and additional evaluation, as well as greater efficiency (for example, 18 months for a decision on registration of new products) are among a number of recommendations by the pesticides review team that will require increases in PY's and resources for all advisor departments including forestry. Although Forestry Canada does not have a seat on the pesticides review team, we have been using several means to present our views:

1. The National Forestry Pesticides Caucus of forest pest management experts was established to represent the forest sector in the review process. The caucus is chaired by Dr. Rod Carrow (Faculty of Forestry, University of Toronto) who holds the one forest sector seat on the review team.

2. The Federal Caucus on Pesticides Review – As only three federal departments have a seat on the pesticides registration review team, this federal caucus was set up to share information and obtain points of view from other departments. Forestry Canada is represented on the federal caucus by Errol Caldwell (FPMI) and Ben Moody (HQ).

3. Also, Forestry Canada submitted a written brief to the review team early in the year.

Therefore, I can assure you that Forestry Canada will maximize its role in the pesticides registration process, and has taken full advantage of the above means to express its views. I was informed of the very poor results of B.t. spray against the spruce budworm across Canada in the 1990 field season. However, I am pleased to see that its importance has deserved a special 1990 B.t. spray results workshop at the forum. Please inform me of the results of your deliberations.

In closing, let me repeat that a priority of Forestry Canada research and technology transfer is the development of innovative pest management techniques essential for successful integrated forest pest management.

At this stage, I would like to end by wishing you a successful, informative, and innovative forum.

J.C. Mercier
Deputy Minister
Forestry Canada

Résumé de l'allocution d'ouverture

Dix-huitième Forum annuel sur la répression des ravageurs forestiers
le 20 novembre 1990, 8 h 30
Pièce du Centenaire, 5^e étage
Centre des conférences, 2, rue Rideau

Au nom de Forêts Canada, j'aimerais vous souhaiter la bienvenue au $XIII^e$ Forum annuel sur la répression des ravageurs forestiers. Depuis que je me suis adressé à vous en novembre dernier, des événements importants pour le Forum se sont déroulés. M. George Green, un fidèle participant et l'un des piliers du Forum, a pris sa retraite le 21 avril. M. Ed Kondo, autrefois directeur de la Direction des agents de lutte biorationelle de l'IRRF a été nommé directeur général de l'Institut. Je suis persuadé qu'Ed continuera d'appuyer le Forum aussi vigoureusement que George, son prédécesseur. Un symposium sur les progrès récentes en matière de répression des ravageurs s'est déroulé à Sault Ste-Marie en octobre de cette année. Il comportait des ateliers de travail et une séance plénière sur la répression de la végétation indésirable et des ravageurs. Le compte rendu des articles qui y ont été présentés sera disponible sous peu.

Le présent Forum est également étroitement lié au mandat du nouveau ministère des Forêts qui consiste à :

- assumer un rôle de chef de file national en matière d'élaboration et de coordination de la politique et des programmes sur les forêts;
- effectuer et favoriser la recherche et le développement dans le secteur des forêts;
- travailler en étroite collaboration avec l'industrie et les gouvernements territoriaux et provinciaux à la gestion et à la protection des forêts.

La mission du nouveau ministère est de "promouvoir le développement durable et la compétitivité du secteur canadien des forêts pour le mieux-être des Canadiens d'aujourd'hui et des générations à venir." La développement durable est la pierre angulaire du plan stratégique de Forêts Canada et orientera les activités de recherche et de développement du ministère. Il est essentiel de protéger nos ressources forestières contre les dégâts causés par les insectes, les maladies, la concurrence végétale et autres types d'organismes nuisibles pour parvenir au développement durable. Les pertes causées par les ravageurs forestiers sont évaluées aux deux tiers de la récolte annuelle.

Les méthodes de répression des ravageurs doivent respecter les désirs du fédéral et du public à l'égard de la conservation de la qualité de l'environnement et de l'intégrité écologique de nos ressources forestières fort diversifiées. Forêts Canada, grâce à des programmes de recherche et de développement et au transfert de la technologie, accordera donc la priorité à la mise au point de méthodes de lutte intégrée contre les ravageurs afin d'encourager l'élaboration de stratégies de répression des ravageurs qui soient acceptables sur le plan environnemental et économiquement viables.

La gestion intégrée des ravageurs forestiers est une composante clé. Ses grands principes peuvent permettre de réprimer les populations de ravageurs, les maladies des arbres et la concurrence végétale. La gestion intégrée des ravageurs forestiers offre une approche écologique à la réduction à des niveaux économiquement acceptables des dommages causés par les ravageurs grâce à une utilisation intégré et bien fondée de divers outils de répression des ravageurs, y compris des prédateurs, des parasites, des agents pathogènes, la biologie des ravageurs, la dynamique des populations, des essences génétiquement améliorées et résistantes, des méthodes sylvicoles, des agents de lutte naturelle et, en dernier ressort, l'utilisation appropriée de pesticides chimiques. La gestion intégrée des ravageurs forestiers n'est pas un concept nouveau, mais n'a pas été appliquée globalement à l'aménagement forestier du Canada. Seuls certains éléments de cette approche ont été appliquées isolément à la répression de la tordeuse des bourgeons de l'épinette, du dendroctone du pin ponderosa, de la spongieuse, des faux guis et des maladies des racines.

La mise au point d'outils de gestion intégrée des ravaguers est l'une des grandes priorités de recherche de Forêts Canada contenues dans les initiatives proposées par le Plan vert et dans les recommandations de l'Équipe d'examen de la réglementation sur les pesticides. Parmi les initiatives proposées par le Plan vert, mentionnons la réalisation de recherches scientifiques sur la gestion intégrée des ravageurs et l'exécution de programmes de surveillance biologique. (Sujets à examiner et figurant à l'ordre du jour du Forum.) Forêts Canada est l'un des chefs de file en matière de surveillance biologique avec son Relevé des insectes et des maladies des arbres (RIMA) et son Dispositif national d'alerte rapide pour les pluies acides (DNARPA). De nombreux pays lui ont fait appel afin de mettre sur pied des réseaux semblables.

Une participation accrue du public et une évaluation plus approfondie, ainsi qu'une plus grande efficacité (p. ex., une période de 18 mois pour décider de l'homologation des nouveaux produits) figurent parmi les recommandations formulées par l'Équipe d'examen de l'homologation des pesticides qui exigeront une augmentation des ressources humaines et financières dans tous les ministères ayant un rôle constutatif, y compris Forêts Canada. Forêts Canada, tout en ne faisant pas partie de l'Équipe d'examen de l'homologation des pesticides a eu recours à plusieurs moyens pour faire connaître ses opinions.

1. Le Comité national des pesticides forestiers, composé d'experts en répression des ravageurs forestiers, a été créé pour représenter le secteur forestier lors du processus d'examen. Le Comité est présidé par Rod Carrow (Faculté de foresterie, Université de Toronto), qui représente le secteur forestier au sein du Comité d'examen.

2. Le Comité fédéral d'examen des pesticides – Puisque seulement trois ministères fédéraux font partie de l'Équipe d'examen de l'homologation des pesticides, ce comité fédéral a été créé afin de diffuser l'information et d'obtenir le point de vue d'autres ministères. Forêts Canada y est 3. Ereprésenté par Errol Caldwell (IRRF) et Ben Moody (AC).

3. Et Forêts Canada a présenté un mémoire écrit à l'Équipe d'examen plus tôt cette année.

Je peux donc vous assurer que Forêts Canada tirera le maximum du rôle qui lui incombe dans le processus d'homologation des pesticides et a tiré pleinement profit des mécanismes susmentionnés pour fair connaître ses opinions. J'ai été informé des piètres résultats du programme canadien de 1990 du pulvérisations de B.t. contre la tordeuse des bourgeons de l'épinette. Je suis toutefois heureux de constater que l'importance du programme de pulvérisations au B.t. de 1990 lui a valu de faire l'objet d'un atelier spécial lors du Forum. Je vous demande de m'informer des résultats de vos entretiens.

En terminant, permettez-moi de vous souligner à nouveau que la mise au point de techniques novatrices de répression des ravageurs, essentielle au succès de la gestion intégré des ravageurs forestiers, est une priorité du programme de recherche et de transfert technologique de Forêts Canada.

Permettez-moi enfin de vous souhaiter que ce forum soit fructueux, instructif et novateur.

J.C. Mercier
Sous-ministre
Forêts Canada

Abstracts/Résumés

The Spruce Budworm in Newfoundland in 1990

A.G. Raske, K.P. Lim and L.J. Clarke

The area of high populations of the spruce budworm doubled in 1990 compared to 1989. The outbreak is confined to one area in southwestern Newfoundland, as populations on the Baie Verte Peninsula declined. High numbers of moths were caught at several locations along the West Coast of Newfoundland in pheromone-baited traps, however these moths are believed to have originated from the Maritime Provinces because local larvae had not yet pupated.

La tordeuse des bourgeons de l'épinette à Terre-Neuve en 1990

A.G. Raske, K.P. Lim et L.J. Clarke

Les superficies abritant des populations élevées de la tordeuse des bourgeons de l'épinette ont doublé en 1990 comparativement à 1989. L'infestation est confinée dans un secteur du sud-ouest de Terre-Neuve, puisque les populations de la presqu'île de la baie Verte ont diminué. Un nombre important de papillons a été capturé en plusieurs endroits le long de la côte ouest de Terre-Neuve dans des pièges à phéromone; ces papillons viendraient toutefois des Maritimes puisque les larves locales ne s'étaient pas encore chrysalidées.

The Hemlock Looper in Newfoundland in 1990

A.G. Raske, K.P. Lim and L.J. Clarke

The areas of hemlock looper defoliation on the Northern Peninsula increased slightly in 1990, but defoliation intensity was very variable and population levels within infested areas decreased. Failure of eggs to hatch was one major factor contributing to decreased population levels. The small areas of defoliation on the Avalon Peninsula continued with shifts in location of severe defoliation.

L'arpenteuse de la pruche à Terre-Neuve en 1990

A.G. Raske, K.P. Lim et L.J. Clarke

Les superficies défoliées par l'arpenteuse de la pruche sur la péninsule Northern ont légèrement augmenté en 1990, mais le degré d'intensité de la défoliation était très variable et les niveaux de population dans les secteurs infestés ont diminué. L'un des principaux facteurs ayant contribué à une diminution des niveaux de population était la non-éclosion des oeufs. Les petits secteurs de défoliation ont persisté sur la presqu'île Avalon où les îlots de défoliation grave ont changé d'endroit.

The Blackheaded Budworm in Newfoundland in 1990

A.G. Raske, K.P. Lim and L.J. Clarke

The outbreak of the blackheaded budworm continued on the Northern Peninsula in the same general area in 1990 as in 1989. Areas of defoliation were at times intertwined with those of the hemlock looper. An experimental spray program tested the efficacy of B.t. for use against this budworm.

La tordeuse à tête noire de l'épinette à Terre-Neuve en 1990

A.G. Raske, K.P. Lim et L.J. Clarke

En 1990, l'infestation de la tordeuse à tête noire de l'épinette s'est poursuivie sur la péninsule Northern dans à peu près la même grande région qu'en 1989. Les secteurs de défoliation chevauchaient quelquefois ceux de l'arpenteuse de la pruche. Un programme expérimental de pulvérisations a permis de vérifier l'efficacité du B.t. contre cette tordeuse des bourgeons.

The Balsam Woolly Adelgid in Newfoundland in 1990

A.G. Raske and W.W. Bowers

Population levels of the balsam woolly adelgid have been steadily rising in the last few years. Of special concern is the increase of this adelgid in young stands that have been thinned or are scheduled for thinning. A special province-wide survey of the western half of the Island indicated eight populations of more than 100 adelgids per 10 nodes. Numerous areas of lower population levels were delineated by the survey. The survey will be completed in the fall of 1990.

Le puceron lanigère du sapin à Terre-Neuve en 1990

A.G. Raske et W.W. Bowers

Au cours des dernières années, les niveaux de population du puceron lanigère du sapin ont régulièrement augmenté. La présence croissante de ce puceron dans de jeunes peuplements qui ont été éclaircis ou qui doivent bientôt l'être est particulièrement préoccupante. Un relevé provincial spécial de la partie ouest de l'île a révélé la présence de huit secteurs renfermant plus de 100 pucerons par 10 nodosités. De nombreux secteurs abritant des niveaux de populations plus faibles ont été pu être délimités grâce à ce relevé. Le relevé sera terminé à l'automne 1990.

The Balsam Fir Sawfly in Newfoundland in 1990

A.G. Raske and L.J. Clarke

An infestation of this sawfly began in 1989 in an area along the southern coast of Newfoundland. This sawfly feeds on old-growth needles only, and mortality of mature trees has occurred in some river valleys. The infestation increased in size in 1990 and also spread into thinned stands.

Le diprion du sapin à Terre-Neuve en 1990

A.G. Raske et L.J. Clarke

Une infestation de ce diprion a débuté en 1989 dans un secteur en bordure de la côte sud de Terre-Neuve. Ce diprion se nourrit uniquement d'aiguilles âgées et la mort d'arbres à maturité a été observée dans certaines vallées fluviales. La superficie du territoire infesté a augmenté en 1990 et l'infestation s'est également propagée dans des peuplements éclaircis.

The Scleroderris Canker in Newfoundland in 1990

G.R. Warren and G.C. Carew

Sporadic infection of pines by Scleroderris canker continued in the St. John's area in 1990. Also, symptoms of the canker re-occurred in the Sitka spruce plantation on the Northern Peninsula, after being without symptoms in the last years.

Le chancre scléroderrien à Terre-Neuve en 1990

G.R. Warren et G.C. Carew

Des pins infectés par le chancre scléroderrien ont continué d'être observés ici et là dans la région de St. John en 1990. Des symptômes de la présence du chancre ont également été à nouveau observés dans la plantation d'épinettes de Sitka de la péninsule Northern, après quelques années d'absence.

Efficacy of B.t. Applications Against the Blackheaded Budworm in Newfoundland in 1990

R.J. West and J. Carter

Oil- and water-based formulations of Bacillus thuringiensis (B.t.), Dipel 176 and Futura SLV were applied twice at a rate of 30 Billion International Units (BIU) per ha over four 45-ha plots in a balsam fir forest in effecacy trials against the eastern blackheaded budworm, Acleris variana (Fern.). Spray coverage was excellent with deposits averaging over one droplet/needle. Population reductions 10 days after the second application ranged from 52 to 94% for Dipel 176 and 84 to 85% for Futura. Analysis of upper-crown samples indicated current-year foliage savings of 0 to 19% for the Dipel treatments and 8 to 50% for the Futura treatments. Whole-tree estimates of current-year defoliation indicated that no foliage was saved in the plots treated with Dipel and that savings of only 1 to 7% resulted from the treatments with Futura. The lack of efficacy was attributed to the feeding behaviour of larvae; the blackheaded budworm feeds within buds and is less likely to ingest a lethal dose of B.t. than a defoliator that feeds openly.

Efficacité des applications de B.t. contre la tordeuse à tête noire de l'épinette à Terre-Neuve en 1990

R.J. West et J. Carter

Des formulations huileuses et aqueuses de Bacillus thuringiensis (B.t.), soit le Dipel 176 et le Futura SLV, ont été appliquées à deux reprises à raison de 30 milliards d'unités internationales (MIU) par hectare sur quatre parcelles de 45 hectares d'une forêt de sapins baumiers lors d'essais visant à vérifier l'efficacité de ces produits contre la tordeuse à tête noire de l'épinette (Acleris variana (Fern.)). Les pulvérisations ont donné d'excellents résultats, les dépôts moyens étant d'une gouttelette/aiguille. Les diminutions de population constatées 10 jours après la deuxième application variaient de 52 à 94 % dans le cas du Dipel 176 et de 84 à 85 % dans le cas du Futura. Des analyses d'échantillons prélevés dans la partie supérieure du houppier ont révélé une protection du feuillage de l'année de 0 à 19 % grâce aux traitements au Dipel et de 8 à 50 % avec Futura. Des estimations de la défoliation de l'année en cours au niveau de l'arbre entier ont révélé que le feuillage n'avait pas été protégé dans les parcelles traitées au Dipel et que la protection procurée par les traitements au Futura ne variait que de 1 à 7 %. Le manque d'efficacité a été attribué au comportement alimentaire des larves; en effet, la tordeuse à tête noire de l'épinette se nourrit à l'intérieur des bourgeons et a moins de chance d'ingérer une dose létale de B.t. qu'un défoliateur qui se nourrit à l'air libre.

Hemlock Looper Decision Support System
A. Raske

A Decision Support System for the management of the hemlock looper in Newfoundland has been developed that consists of six user-friendly integrated computer models. The models incorporate several data bases: FIDS sampling records, FIDS defoliation maps, weather data, and research data. The System predicts the risk of the initial outbreak, the risk of initial defoliation, the risk of continued defoliation, the severity of tree mortality, and the risk of decay of killed trees. The user has certain options including successful/unsuccessful, partial/complete, and biological/chemical spray operations. One model of the system predicts larval hatch and development to assist in the timing of larval sampling and in spray operations.

Système de soutien à la prise de décisions relatives à l'arpenteuse de la pruche
A. Raske

Un système de soutien à la prise de décisions relatives à l'arpenteuse de la pruche à Terre-Neuve a été mis au point et comporte six modèles informatiques intégrés et simplifiés. Les modèles comprennent plusieurs bases de données : les relevés des échantillonnages du RIMA, les cartes de défoliation du RIMA, des données météorologiques et des données de recherche. Le système prédit le risque d'infestation initiale, le risque de défoliation initiale, le risque de progression de la défoliation, la gravité de la mortalité et le risque que les arbres tués pourrissent. L'utilisateur dispose de certaines options dont les suivantes : opérations de pulvérisation fructueuses/infructueuses, partielles/totales et biologiques/chimiques. L'un des modèles prédit l'éclosion des larves et leur développement, aidant ainsi à déterminer la période d'échantillonnage des larves et des opérations de pulvérisation.

Insect Control Programs in Newfoundland in 1990
H. Crummey

No spray operation was conducted against the Black Army cutworm and the spruce budworm, due to low population levels. A total of 12 blocks (10 616 ha) were treated with B.t. for the hemlock looper.

Programmes de lutte contre les insectes à Terre-Neuve en 1990
H. Crummey

Aucune pulvérisation pour lutter contre la légionnaire noire et la tordeuse des bourgeons de l'épinette n'a été menée en raison de leurs faibles niveaux de population. Au total, 12 blocs (10 616 ha) ont été traités au B.t. pour y lutter contre l'arpenteuse de la pruche.

Forest Pest Conditions in the Maritimes in 1990
L.P. Magasi

Significant forest pest conditions which occurred in the Maritimes Region in 1990 have been reported in Forestry Canada-Maritimes Technical Notes 237, 238, 239 and 241. Copies of these are included in the Forum Report.

Insectes et maladie des arbres dans les Maritimes en 1990
L.P. Magasi

Les Notes techniques 237, 238, 239 et 241 de Forêts Canada-Maritimes portent sur les insectes et maladies des arbres d'importance qui ont été observés dans les Maritimes en 1990. Les exemplaires de ces notes ont été annexés au compte rendu du Colloque.

Spruce Budworm Population, Hemlock Looper Population, Herbicide Use in Nova Scotia, 1990
T.D. Smith and E. Georgeson

The area of spruce budworm population in Nova Scotia has increased by 40 percent with significant areas of moderate population densities occurring on the Cape Breton Highlands. Persistent areas of high (10 000 ha) and extreme (3 250 ha) were noted in Inverness County and these areas will require careful monitoring. This year's weather conditions were favourable for adult migrations but no spruce budworm or hemlock looper moth flights we were noted from the light trap survey.

Population de la tordeuse des bourgeons de l'épinette et de l'arpenteuse de la pruche et utilisation d'herbicides en Nouvelle-Écosse en 1990
T.D. Smith et E. Georgeson

Les superficies ravagées par des populations de la tordeuse des bourgeons de l'épinette en Nouvelle-Écosse ont augmenté de 40 %, de vastes territoires présentant des densités de population modérées dans les hautes terres de l'île du Cap-Breton. Des secteurs persistants de densité élevée (10 000 ha) et extrême (3 250 ha) ont été signalés dans le comté d'Inverness et devront faire l'objet d'une surveillance attentive. Les conditions météorologiques ayant prévalu cette année favorisent la migration des adultes, mais aucun envol de papillons de la tordeuse des bourgeons de l'épinette ou de l'arpenteuse de la pruche n'a été signalé à la suite du relevé au piège lumineux.

1990 New Brunswick Protection Program Against Spruce Budworm
N. Carter

The 1990 Spruce Budworm Spray Program conducted by Forest Protection Limited, in New Brunswick covered approximately 533 200 hectares. This is 7.6% less than the 576 900 ha treated in 1989. Another 28 600 ha were sprayed by J.D. Irving Ltd. on its own freehold limited (compared to 34 000 ha in 1989).

Programme de protection contre la tordeuse des bourgeons de l'épinette du Nouveau-Brunswick de 1990
N. Carter

Le programme de pulvérisation de 1990 contre la tordeuse des bourgeons de l'épinette mené par la Forest Protection Limited au Nouveau-Brunswick a permis de traiter environ 533 200 hectares, soit 7,6 % de moins que les 576 900 hectares pulvérisés en 1989. De plus, la J.D. Irving Ltd. a traité 28 600 hectares de ses propres terres (comparativement à 34 000 hectares en 1989).

1990 Hemlock Looper Spray Program in New Brunswick
L. Hartling and N. Carter

This report provides results of an operational assessment of spray operations in 1990 which was the first hemlock looper control program ever conducted in New Brunswick. An area of 21 160 ha in northern New Brunswick encompassing virtually all of the forecast was treated in 1990.

The two larger blocks, which totalled 17 805 ha, received three applications of insecticide as follows: one application of fenitrothion followed by one application of *B.t.* (Future XLV) followed by a second application of fenitrothion. The smallest block, 23 355 ha in size, was treated with two applications of *B.t.*

Programme de pulvérisation du Nouveau-Brunswick de 1990 contre l'arpenteuse de la pruche
L. Hartling and N. Carter

Le présent rapport décrit les résultats d'une évaluation opérationnelle du premier programme de pulvérisations contre l'arpenteuse de la pruche jamais mené au Nouveau-Brunswick. En 1990, une superficie de 21 160 hectares a été traitée dans le nord du Nouveau-Brunswick, correspondant à la presque totalité de la zone où l'infestation avait été prédite.

Les deux blocs les plus grands d'une superficie totale de 17 805 hectares ont reçu trois applications d'insecticide, soit une application de fenitrothion suivie d'une application de *B.t.* (Futura XLV), suivie d'une deuxième application de fenitrothion. Le bloc le plus petit d'une superficie de 23 355 hectares a reçu deux applications de *B.t.*

La tordeuse des bourgeons de l'épinette au Québec en 1990

L. Dorais et Michel Auger

Les conditions météorologiques défavorables ont énormément retardé les opérations de pulvérisation et des traitements ont dû être annulés sur 103 651 hectares. Le programme de pulvérisation de 1990 a été effectué sur une superficie totale de 479 896 hectares, 211 809 hectares ayant reçu une double application de B.t.

En 1990, l'infestation s'étendait sur une superficie totale de 1,25 million d'hectares situés en grande partie (1,1 million d'hectares) en Gaspésie. Les dégâts étaient légers sur 0,38 million d'hectares, modérés sur 0,31 million d'hectares et graves sur 0,56 million d'hectares.

The Spruce Budworm in Quebec 1990

L. Dorais and Michel Auger

Poor weather conditions considerably delayed the spray operations and treatment had to be cancelled on 103 651 hectares. The 1990 spray program was carried out on a total surface area of 479 896 hectares, of which 211 809 hectares received a double application of B.t.

In 1990, the infestation covered a total area of 1.25 million hectares, of which almost 1.1 million were in the Gaspé Peninsula. Damage was light over 0.38 million hectares, moderate over 0.31 million hectares and severe over 0.56 million hectares.

Spruce Budworm in Ontario, 1990

G.M. Howse, J.H. Meating and J.J. Churcher

The area infested by spruce budworm in Ontario increased in 1990 for the second consecutive year. Province-wide, a total of 6,783,261 ha of moderate-to-severe defoliation were mapped by aerial and ground surveys. This represents an increase of 543,625 ha over the 6,239,636 ha recorded last year. It should be pointed out that these figures represent gross areas within which defoliation occurred. Most of the defoliation again occurred in the Northwestern and North Central regions.

A total of 49 627 ha was aerially sprayed (with B.t.) in 1990 in the Northwestern and North Central Regions.

La tordeuse des bourgeons de l'épinette en Ontario en 1990

G.M. Howse, J.H. Meating et J.J. Churcher

La superficie infestée par la tordeuse des bourgeons de l'épinette en Ontario a augmenté en 1990 pour une deuxième année consécutive. Au total, dans la province, 6 783 261 hectares de défoliation modérée à grave ont été cartographiés grâce à des relevés aériens et au sol. C'est là une augmentation de 543 625 hectares qui s'ajoutent aux 6 239 636 hectares relevés l'an dernier. Il est à noter que ces chiffres représentent des superficies approximatives de défoliation. Ce sont à nouveau les régions du nord-ouest et du centre-nord qui ont été victimes de la majeure partie de cette défoliation.

Au total, 49 627 hectares ont reçu des pulvérisations aériennes (au B.t.) en 1990 dans les régions du nord-ouest et du centre-nord.

Gypsy Moth in Ontario, 1989

J.H. Meating, G.M. Howse and J.J. Churcher

Despite the steady spread of the gypsy moth into new areas of the province, the area of moderate-to-severe defoliation declined slightly in 1990 to a total of 77,648 ha, compared to a total of 81,640 ha in 1989.

In 1990, the Ontario Ministry of Natural Resources aerially sprayed with B.t. a total of 33 956 ha of forest in southern Ontario to protect stands from defoliation by gypsy moth.

La spongieuse en Ontario en 1989

J.H. Meating, G.M. Howse et J.J. Churcher

Malgré la progression régulière de la spongieuse dans de nouveaux secteurs de la province, la superficie de défoliation modérée à grave a légèrement diminué en 1990 pour atteindre un total 77 648 hectares, comparativement à 81 640 hectares en 1989.

En 1990, le ministère des Richesses naturelles de l'Ontario a effectué des pulvérisations aériennes de B.t. sur un total de 33 956 hectares de forêt du sud de l'Ontario afin de protéger les peuplements de la défoliation causée par la spongieuse.

Northwest Region
Status of Important Forest Pests and Operational/ Experimental Control Projects
H. Cerezke et al.

This report summarizes information on the current status of: Spruce Budworm, Mountain Pine Beetle, Jack Pine Budworm, Forest Tent Caterpillar, Pinewood Nematode and several lesser important pest species, distribution and pest management.

Région du Nord-Ouest
État des populations des ravageurs forestiers d'importance et projet de lutte expérimentale
H. Cerezke et al.

Ce rapport résume les données existantes fur l'[état actuel des populations de la tordeuse des bourgeons de l'épinette, du dendroctone du pin ponderosa, de la tordeuse du pin gris, de la livré des forêts, du nématode du pin et de plusieurs autres espèces de ravageurs moins importantes et précise l'aire de distribution connue de ces insectes et les mesures de lutte dont ils font l'objet.

Forest Pests in Manitoba
A.R. Westwood, Y. Beaubien, L. Christianson, R. Khan, K. Knowles, L. Matwee and I. Pines

This report summarizes the following: Spruce budworm, jack pine budworm; pine root collar weevil; pest surveys in renewed forests, dwarf mistletoe management, Dutch Elm Disease management; Armillaria root rot; and testing superior jack pine stock for resistance to western gall rust.

Ravageurs forestiers en Manitoba en 1990
A.R. Westwood, Y. Beaubien, L. Christianson, R. Khan K. Knowles, L. Matwee and I. Pines

Parmi les rapport récapitulatifs présentés, mentionnons ceux portant sur la tordeuse des bourgeons de l'épinette, la tordeuse du pin gris, le charançon du collet du pin, les relevés des ravageurs dans les forêts régénérées, la répression du faux gui et de la maladie hollandaise de l'orme, le pourridié-agaric et l'essai de pins gris génétiquement supérieurs pour connaître leur résistance à la rouille-tumeur globuleuse.

Alberta Spruce Budworm Management Program in 1990

H. Ono

In 1990, there were major spruce budworm outbreaks at Chinchaga River (95 000 ha), Bovine Creek and House River (12 145 ha), Hawk Hills (1 000 ha), and Eaglesham (1 200 ha). The budworm management program in 1990 composed of:

a) Aerial spraying of bacterial insecticide, B.t. on 12 000 ha, to reduce the defoliation thus keeping the severely infested trees alive.

b) Presalvage harvesting to reduce the potential economic losses, should the trees begin to die due to severe budworm infestations. Presalvage harvesting of 153 000M^3 of mature timber is scheduled to begin in the winter of 1990.

Programme de répression de la tordeuse des bourgeons de l'épinette en Alberta en 1990

H. Ono

En 1990, des infestations majeures de la tordeuse des bourgeons de l'épinette se sont produites dans la région de la rivière Chinchaga (95 000 hectares), du ruisseau Bovine et de la rivière House (12 145 hectares), de Hawk Hills (1 000 hectares) et d'Eaglesham (1 200 hectares). Le programme de répression de la tordeuse des bourgeons de 1990 comportait :

a) la pulvérisation aérienne au B.t., un insecticide biologique, de 12 000 hectares afin de réduire la défoliation et de garder en vie les arbres gravement infestés;

b) une coupe de prérécupération destinée à réduire les pertes économiques éventuelles advenant le cas où les arbres commenceraient à mourir en raison de graves infestations par la tordeuse des bourgeons. La coupe de prérécupération de 153 000 m^3 d'arbres à maturité devrait débuter au cours de l'hiver 1990.

Pacific Region - 1990 Status of Important Forest Pests, Experimental Control Projects and Vegetation Management Research

G.A. Van Sickle et al.

The status of more than 19 forest pests in 1990 is presented with some forecasts for 1991. These include the declining but continuing populations and significant damage by mountain pine beetle, the decline in black army cutworm, rhizina root disease, and blackheaded budworm, increasing levels of western hemlock looper, grey spruce looper, and gypsy moth.

Current research progress and control trials of some of these pests include: biological control research directed to spruce weevil, larch casebearer, winter moth and vegetation management; B.t. trials against blackheaded budworm; pathogenicity testing with pinewood nematode and hazard rating and model systems for mountain pine beetle.

Région du Pacifique - 1990
État des populations de ravageurs forestiers d'importance, projets expérimentaux de lutte et recherche sur la gestion des végétaux

G.A. Van Sickle et al.

Le document présente l'état des populations de plus de 19 ravageurs forestiers ayant causé des dommages en 1990 ainsi que certaines prévisions pour 1991. Parmi ces ravageurs, mentionnons les populations à la baisse, mais persistantes, du dendroctone du pin ponderosa et les dégâts importants qu'elles causent, le déclin des populations de la légionnaire noire et de la tordeuse à tête noire ainsi que des infections causées par le pourridié rhizinéen et l'augmentation des populations de l'arpenteuse de la pruche de l'Ouest, de l'arpenteuse grise de l'épinette et de la spongieuse.

Parmi les recherches en cours qui progressent et les essais de lutte contre certains de ces ravageurs, mentionnons la recherche sur les outils de lutte biologique contre le charançon de l'épinette, le porte-case du mélèze et l'arpenteuse tardive ainsi que sur la gestion des végétaux, les pulvérisations expérimentales de B.t. contre la tordeuse à tête noire, les essais de pathogénécité avec le nématode du pin et l'élaboration de systèmes de modélisation et de classification des risques d'infestation par le dendroctone du pin ponderosa.

1990 Pest Control Forum - B.C. Ministry of Forests Report

P.M. Hall and J.A. Muir

Pest management programs continue to address specific pest problems relating to insects, diseases, vertebrate pests and others. The name of the section has been changed from Pest Management to Forest Health.

Mountain pine beetle remains the most important pest in many areas of the province. The total area affected has declined somewhat in 1990.

Forum sur la Répression des Ravageurs Forestiers de 1990 - rapport du Ministère des Forêts de la C.-B.

P.M. Hall et J.A. Muir

Les programmes de répression des ravageurs ont continué d'aborder certains problèmes particuliers posés par des insectes, des maladies, des ravageurs vertébrés et autres. La section de la répression des ravageurs s'appelle maintenant la section de la protection de la santé des arbres.

Le dendroctone du pin ponderosa reste toujours le ravageur le plus important dans de nombreux secteurs de la province. La superficie totale infestée a légèrement diminué en 1990.

Gypsy Moth Conditions - Maine 1990

Dick Bradbury

Gypsy moth defoliated 270,537 acres in 1990, continuing its epidemic phase which began in 1989 in Maine. Populations remain in the southwestern portion of the State where hardwoods, particularly red oak, are the predominant species.

Suppression projects in 1990 were entirely privately contracted and funded using both ground and aerial methods of application. B.t. was utilized almost exclusively on the approximately 2000 acres treated.

État des populations de la spongieuse dans le Maine en 1990

Dick Bradbury

En 1990, la spongieuse a défolié 270 537 acres, poursuivant son cycle d'infestation qui a débuté en 1989 dans le Maine. Les populations sont restées confinées dans la partie sud-ouest de l'État où des feuillus, notamment le chêne rouge, sont les essences dominantes.

En 1990, les projets de répression ont été entièrement donnés à des entrepreneurs privés qui ont assumé les coûts des pulvérisations au sol et aériennes. Le B.t. a été presque exclusivement utilisé sur les 2 000 acres traitées.

The Status of the Hemlock Looper in Maine - September 1990

H. Trial

An aerial survey was conducted during September of 1990 over much of Maine. More than 20,000 acres of heavy to severe damage was mapped. Light to moderate damage was not visible from the air but ground observation suggests that areas of light to moderate damage may exceed 80,000 acres.

État des populations de l'arpenteuse de la pruche dans le Maine en Septembre 1990

H. Trial

En septembre 1990, un relevé aérien a été effectué presque partout dans le Maine. Il a permis de cartographier plus de 20 000 acres de défoliation forte à grave. Les dégâts légers à modérés n'étaient pas visibles du haut des airs, mais des observations au sol laissent supposer que les superficies légèrement à modérément atteintes pourraient dépasser les 80 000 acres.

Gypsy Moth Status - USA
D. Kucera

Gypsy moth populations and defoliation continued to expand throughout the Northeastern United States and central Michigan in 1990. Total defoliation was 7,297,962 acres, up from 2,995,559 acres in 1989 and 719,302 acres reported in 1988. Of the 7.29 million defoliated acres, 4,357,700 or 60 percent occurred in Pennsylvania. This is nearly twice that treated in 1989. Private landowners may have treated another one million acres.

État des populations de la spongieuse aux États-Unis
D. Kucera

Les populations de la spongieuse et la défoliation qu'elles provoquent ont continué de gagner du terrain partout dans le nord-est des États-Unis et dans le centre de l'État du Michigan en 1990. La superficie totale défoliée était de 7 297 962 acres, une augmentation comparativement aux 2 995 559 acres de 1989 et aux 719 302 acres de 1988. 4 357 700 acres, ou 60 % des 7,29 millions d'acres défoliées, se retrouvaient en Pennsylvanie. C'est là près de deux fois la superficie traitée en 1989. Les propriétaires privés ont probablement traité un autre million d'acres.

Summary of FPMI and Forest Sector Major Initiatives
Errol Caldwell

Changes in research focus are taking place at FPMI in response to departmental and FPMI strategic plans. The key areas identified in FPMI's Strategic Plan were described earlier in Dr. Kondo's presentation. Some of these key initiatives will become apparent during some of FPMI's presentations or are included in separate staff Forum reports. A very brief summary of key directions is given.

Résumé des principales activités de l'IRRF et du secteur des forêts
Errol Caldwell

Les programmes de recherche de l'IRRF sont réorientés conformément aux plans stratégiques du Ministère et de l'IRRF. Les principaux domaines identifiés dans le plan stratégique de l'IRRF ont été décrits précédemment lors de l'exposé de M. Kondo. Certaines de ces initiatives d'importance deviendront plus évidentes lors des exposés que présenteront des employés de l'IRRF ou sont l'objet de rapports distincts soumis par le personnel au Forum. Un très bref résumé des grandes orientations est présenté.

Canadian Vegetation Management Alliance (CVMA) Activities in 1990
Phillip E. Reynolds, President

As previously reported (17th Annual Pest Forum Report), the Alliance was federally incorporated in October 1988. An attached brochure provides a list of our members and explains the CVMA's goal, objectives, and current and future activities.

Activités de la Canadian Vegetation Management Alliance en 1990
Phillip E. Reynolds, Président

Comme nous l'avons signalé précédemment (rapport du 17ᵉ Forum annuel sur la répression des ravageurs), l'Alliance a été constituée sous le régime de la loi fédérale en octobre 1988. Une brochure ci-jointe présente une liste de nos membres et explique le but, les objectifs et les activités actuelles et futures de notre organisation.

Research on the Toxicity of Insecticides to Forest Insect Pests in 1990
B.V. Helson, J.W. McFarlane and D.R. Comba

We have been assessing the potential of 4 new insecticides for the control of forest pests: alpha-terthienyl, RH5992, abamectin and its semi-synthetic derivative, MK-243 in the laboratory.

In 1990, D.B. Lyons, Forestry Canada, Ontario Region, and I collaborated in laboratory and field trials to develop an insecticide control strategy for the pine false webworm on red pine.

Recherche de 1990 sur la toxicité des insecticides pour les ravageurs forestiers
B.V. Helson, J.W. McFarlane et D.R. Comba

Nous avons évalué en laboratoire le potentiel de quatre nouveaux insecticides, soit l'alpha-terthienyl, le RH5992, l'abamectin et son dérivé semi-synthétique et le MK-243.

En 1990, D.B. Lyons de Forêts Canada, région de l'Ontario, et moi-même avons collaboré à des essais en laboratoire et sur le terrain afin d'élaborer une stratégie faisant appel à des insecticides et permettant de lutter contre le pamphile introduit du pin, un ravageur du pin rouge.

White Pine Weevil Control Research Trials in Ontario

Peter de Groot, Blair Helson, Bert Zylstra, John McFarlane, and Dave Comba

White pine weevil, Pissodes strobi (Peck), has become a serious pest in many jack pine and black spruce plantations in Ontario and elsewhere. Therefore, the purpose of our study was to develop an effective control method for the control of white pine weevil in seed orchards and other high value stands where little or no leader loss is wanted. Reported here are the preliminary analyses of the bioassay and damage appraisal data from spray trials with methoxychlor and permethrin.

Essais de répression du charançon du pin blanc en Ontario

Peter de Groot, Blair Helson, Bert Zylstra
John McFarlane et Dave Comba

Le charançon du pin blanc (Pissodes strobi (Peck)) est devenu un ravageur d'importance dans de nombreuses plantations de pins gris et d'épinettes noires de l'Ontario et d'ailleurs. Par conséquent, notre étude avait pour but d'élaborer une méthode efficace de lutte contre le charançon du pin blanc dans les vergers à graines et autres peuplements de grande valeur où il est souhaitable de limiter ou d'éviter les pertes de pousses apicales. Nous faisons ici état des analyses préliminaires du bio-essai et des données d'évaluation des dégâts à la suite des pulvérisations expérimentales au méthoxychlore et à la permethrine.

Insect Growth Regulator Update for 1990

Arthur Retnakaran, Bill Tomkins and Larry Smith

Insect growth regulators (IGRs) belong to a new generation of pesticide called biorationals. Various classes of these compounds are being developed to control insects by interfering with their growth and development.

The 1990 field season was reserved for the testing of Dimilin, a chitin inhibitor, against the white pine weevil and for initial probes of the ecdysonoid, RH-5992, against the spruce budworm.

In the laboratory, work is continuing on attempts to isolate and use a microsporidian plasmid as a vector to insert deleterious genes for insect control.

Mise à jour de 1990 sur les régulateurs de croissance des insectes

Arthur Retnakaran, Bill Tomkins et Larry Smith

Les régulateurs de croissance des insectes (RCI) appartiennent à une nouvelle génération de pesticides dits biorationnels. Diverses catégories de tels composés qui influent sur la croissance et le développement des insectes sont mises au point pour lutter contre les insectes.

La campagne sur le terrain de 1990 a servi à faire des essais avec le Dimilin, un inhibiteur de la mue, pour lutter contre le charançon du pin blanc et des essais exploratoires de l'ecdysonoide, le RH-5992, pour lutter contre la tordeuse des bourgeons de l'épinette.

Les travaux en laboratoire se poursuivent pour tenter d'isoler et d'utiliser un plasmide microsporidien comme vecteur pour insérer des gènes nuisibles à des fins de répression des insectes.

Use of Lecontvirus in 1990

J.C. Cunningham and W.J. Kaupp

Lecontvirus (nuclear polyhedrosis virus) for control of redheaded pine sawfly was supplied to Ontario Ministry of Natural Resources staff in 6 districts. They treated 49 red pine and jack pine plantations with a total area of 677 ha. A request from Quebec Department of Energy and Resources came too late to apply virus for insect control in 1990. However, material will be available for use in Quebec as well as Ontario in 1991. Lecontvirus is the only registered viral insecticide which is currently used on an annual basis in Canada.

Utilisation du Lecontvirus en 1990

J.C. Cunningham et W.J. Kaupp

Le Lecontvirus, un virus de la polyédrose nucléaire qui permet de lutter contre le diprion de Le Conte, a été fourni à six bureaux de district du ministère des Richesses naturelles de l'Ontario. Son personnel a traité 49 plantations de pins rouges et de pins gris d'une superficie totale de 677 hectares. Une demande émanant du ministère de l'Énergie et des Ressources du Québec est arrivée trop tard pour que le virus soit utilisé contre cet insecte en 1990. Toutefois, le Québec et l'Ontario disposeront de ce virus en 1991. Le Lecontvirus est le seul insecticide viral homologué qui soit actuellement utilisé chaque année au Canada.

Application of Gypchek Against Gypsy Moth in Ontario 1990

J.C. Cunningham, W.J. Kaupp, G.G. Grant, K.W. Brown and D. Frech

Gypchek (nuclear polyhedrosis virus) supplied by the USDA Forest Service was applied in an emulsifiable oil tank mix when larvae were mainly in the first instar. Two applications of $5X10^{11}$ polyhedral inclusion bodies (PIB)/ha (total of 10^{12} PIB/ha) were applied 7 days apart. The tank mix contained 25% Dipel 176 blank carrier vehicle supplied by Abbott Laboratories and 75% water. Plots were located in Simcoe District. Treatments were on three 10 ha plots which had pre-spray gypsy moth egg mass densities ranging from 3080 to 7560/ha. These were paired with two check plots which had 2920 and 6690 egg masses/ha.

Population reductions due to the treatments (Abbott's formula) were 87, 92 and 92%. The treatments were considered highly effective with defoliation ranging from 29 to 35% compared to 77 and 93% on the two check plots. Post-spray egg mass counts in the treated plots ranging from 556 to 880/ha were well below the 1200/ha threshold level which is considered acceptable.

Application de Gypchek contre la spongieuse en Ontario en 1990

J.C. Cunningham, W.J. Kaupp, G.G. Grant, K.W. Brown et D. Frech

Le Gypchek (virus de la polyédrose nucléaire) fourni par le Service des forêts des États-Unis a été appliqué dans un mélange d'huile émulsionnable lorsque la plupart des larves en étaient à leur premier stade. Deux applications de 5 X 10^{11} corps d'inclusion polyédriques (CIP)/hectare (total de 10^{12} CIP/ha) ont été effectuées à 7 jours d'intervalle. Le mélange en cuve contenait 25 % du support utilisé habituellement pour le Dipel 176 fourni par Abbott Laboratories et 75 % d'eau. Les parcelles étaient situées dans le district de Simcoe. Les traitements ont été effectués dans trois parcelles de 10 hectares où les densités pré-traitement de masses d'oeufs de la spongieuse variaient de 3 080 à 7 560/ha. Ces parcelles étaient jumelées à deux parcelles témoins qui avaient 2 920 et 6 690 masses d'oeufs/ha.

Les réductions de populations attribuables aux traitements (formule Abbott) étaient de 87, 92 et 92 %. Les traitements ont été jugés très efficaces, la défoliation variant de 29 à 35 %, comparativement à 77 et 93 % dans les deux parcelles témoins. Les dénombrements post-traitement des masses d'oeufs dans les parcelles traitées qui variaient de 556 à 880/ha étaient très en-deçà du seuil de 1 200/ha qui est jugé acceptable.

Application of Disparvirus Against Gypsy Moth in Ontario in 1990

J.C. Cunningham, W.J. Kaupp, G.G. Grant, K.W. Brown,
M.B.E. Cunningham, P. Ebling and D. Frech

Two emitted volumes, 2.5 L/ha and 5.0 L/ha, of Disparvirus (nuclear polyhedrosis virus) produced at FPMI, were compared using a double application of 5X10^{11} polyhedral inclusion bodies (PIB)/ha (total 10^{12} PIB/ha) in an aqueous tank mix containing 25% (v/v) Rhoplex B60A sticker. Plots were located in Simcoe District. The two treatments were replicated on three 10 ha plots which were paired with three check plots with similar pre-spray egg mass densities which ranged from 2280 to 8900/ha. The two applications were 5 days apart and gypsy moth larvae were mainly in the first instar.

Population reductions due to treatment (Abbott's formula) in the plots treated at 2.5 L/ha were 73, 82 and 90% and in the plots treated at 5.0 L/ha were 87, 91 and 95%. For a successful gypsy moth spray application, defoliation on treated plots should not exceed 40% and post-spray egg mass densities should not exceed

1200/ha. Using these criteria, the 2.5 L/ha application was only marginally effective and a 5.0 L/ha emitted volume is recommended for application of Disparvirus.

Application de Disparvirus pour lutter contre la spongieuse en Ontario en 1990

J.C. Cunningham, W.J. Kaupp, G.G. Grant, K.W. Brown,
M.B.E. Cunningham, P. Ebling and D. Frech

Deux volumes de pulvérisation, soit 2,5 L/ha et 5,0 L/ha, de Disparvirus (virus de la polyédrose nucléaire) produits à l'IRRF ont été comparés lors d'une double application de 5 X 10^{11} corps d'inclusion polyédriques (CIP)/ha (total de 10^{12} CIP/ha) en mélange aqueux contenant 25 % (v/v) d'adhésif Rhoplex B60A. Les parcelles étaient situées dans le district de Simcoe. Les deux traitements étaient assortis de répétitions dans trois parcelles de 10 hectares qui étaient jumelées à trois parcelles témoins ayant des densités pré-traitement de masses d'oeufs similaires variant de 2 280 à 8 900/ha. Les deux applications ont été effectuées à 5 jours d'intervalle et les larves de la spongieuse en étaient pour la plupart à leur premier stade.

Les réductions de populations attribuables au traitement (formule d'Abbott) dans les parcelles traitées avec des volumes de 2,5 L/ha étaient de 73, 82 et 90 % et dans celles traitées avec 5,0 L/ha, elles atteignaient 87, 91 et 95 %. Pour que des pulvérisations contre la spongieuse soient fructueuses, la défoliation des parcelles traitées ne devrait pas dépasser 40 % et les densités post-traitement de masses d'oeufs ne devraient pas être supérieures à 1 200/ha. En se basant sur ces critères, l'application d'un volume de 2,5 L/ha n'a eu qu'une efficacité marginale et le volume de 5,0 L/ha est recommandé lors de l'application du Disparvirus.

Studies on the Environmental Chemistry of Forestry Insecticides

K.M.S. Sundaram, R. Nott and J. Curry

Major studies conducted by the Insecticide Chemical Accountability Project of the Forest Pest Management Institute during 1989-90 are highlighted. The studies were examined include (1) the distribution, deposition and persistence of Bacillus thuringiensis (Kurstaki) [B.t. (k)] in a deciduous forest environment, (2) force feeding bioassays of [B.t. (k)] on spruce budworm, (3) the control of seed and cone insects in black spruce, Picea mariana (Mill.), by trunk implantation of acephate as Acecap capsules, (4) the fate, persistence, partitioning and accumulation of permethrin in a forest stream environment, (5) the analysis of bound insecticide residues in forest soil and foliage under laboratory conditions, and (6) the influence of foliar morphology and surface characteristics on the droplet reception and retention of insecticides.

Études sur le devenir chimique des insecticides forestiers dans l'environnement

K.M.S. Sundaram, R. Nott et J. Curry

Les points saillants des principales études effectuées par le personnel du projet sur le devenir chimique des insecticides de l'Institut pour la répression des ravageurs forestiers en 1989-1990 sont présentés. Parmi les études examinées, mentionnons 1) la distribution, le dépôt et la persistance de Bacillus thuringiensis (Kurstaki) [B.t. (k)] en forêt feuillue, 2) des essais d'absorption forcée de [B.t. (k)] chez la tordeuse des bourgeons de l'épinette, 3) la répression des ravageurs des cônes et des graines d'épinette noire (Picea mariana (Mill.)) par implantation sur le tronc d'acéphate sous forme de capsules Acecap, 4) le devenir, la persistance, la séparation et l'accumulation de la permethrine dans un cours d'eau en milieu forestier, 5) l'analyse en laboratoire des résidus d'insecticides liés dans le sol forestier et sur le feuillage et 6) l'influence de la morphologie du feuillage et des caractéristiques en surface sur la réception et de la rétention des gouttelettes d'insecticide.

Research Studies on Physicochemical Aspects of Pesticide Performance (conducted in 1990)

A. Sundaram and J.W. Leung

During 1990, the Pesticide Formulations Project at FPMI undertook two field studies and two laboratory studies to examine (A) rainfastness of foliar deposits of B.t. and glyphosate formulations under field conditions; and (B) influence of adjuvants on rainfastness of glyphosate; and role of physical properties of end-use mixtures of B.t. on droplet size spectra of the spray cloud, droplet spreading on foliage, and deposits on glass plates, under laboratory conditions.

Études des aspects physico-chimiques de l'efficacité des pesticides (menées en 1990)

A. Sundaram et J.W. Leung

En 1990, le projet sur les formulations des pesticides de l'IRRF a entrepris deux études sur le terrain et deux autres en laboratoire afin d'examiner a) la stabilité à la pluie sur le terrain des formulations de B.t. et de glyphosate déposées sur les aiguilles et b) l'influence des adjuvants sur la stabilité à la pluie du glyphosate ainsi que le rôle des propriétés physiques des mélanges de B.t. utilisés sur le spectre de grosseur des gouttelettes du nuage de pulvérisation, sur la dispersion des gouttelettes sur le feuillage et sur le dépôt sur des plaques de verre, en laboratoire.

Droplet Distribution and Efficacy Against Spruce Budworm Larvae of Undiluted Dipel^R Formulations Using Micronair AU4000

In order to optimize the efficacy of aerial application of Bacillus thuringiensis (B.t.) against spruce budworm (Choristoneura fumiferana (Clem.) larvae, undiluted and concentrated Dipel^R oil formulations were used in 1988 and 1989 field experiments. Dipel^R 12L and Dipel^R 16L, containing 25.4 and 33.8 BIU/L respectively, were applied at 15 and 30 BIU/ha in 0.4, 0.55, and 1.1 L/ha as ultra ultra low volume (UULV) from two Cessna 188s, each equipped with four Micronair AU4000s. Day Glo Orange Dye was used as a tracer for evaluation of spray deposits.
The spruce budworm microhabitat in balsam fir (Abies balsamea (L.)Mill.) consists primarily of larval silk and new needles on developing shoots, and it rarely incorporates one-year-old needles at the time of B.t. spraying. The needles of developing shoots are tied together with the silk to form a case or nest, in which the larvae live. They feed for the most part on needles within the case at this stage. Setae and other parts of the larva remain in constant contact with microhabitat silk.

To improve the efficacy of B.t., a stomach poison, it is essential to determine the characteristics of droplets reaching larval feeding sites. Droplet deposits were measured on Kromekote^R cards, foliage simulators, natural needles, silk of microhabitats, and artificial harps made of larval silks to determine the droplet spectra deposited on the plots, target sites, and budworm silk. In 1988, Dipel^R 12L was applied at 15 and 30 BIU/ha in 0.55 and 1.1 L/ha respectively. The trend in mean deposit on year-old and current needles in the 15 and 30 BIU treatments was normal, i.e., more deposit was found in the higher application rate. However, the trend in mean deposit on microhabitat silk was reversed. There was more deposit per microhabitat at 15 BIU than at 30 BIU, due to the higher number and frequency of smaller droplets (<35µm). In 1989, Dipel^R 16L was applied at 0.4L/ha for 15 BIU and 0.4L/ha twice for 30 BIU. The flow rate, 2L/min/head, was kept constant in order to have similar droplet spectra. The deposit was measured on larval silk secured to harps, current needles, and year-old needles in the 30 BIU plot. Approximately 42% of the droplets on the harp samplers were <10µm and 80% were <40µm.

Video cameras were used to study the interaction of larvae and droplets and the mechanisms involved in the transfer of B.t. to feeding sites. Residual toxicity of the spectra produced by 15 and 30 BIU applications of the two formulations was studied and the effects of weather parameters were evaluated. The lower volume, higher active ingredient concentration, and enhanced atomization of the Dipel^R 16L formulation improved the residual toxicity, and thus the efficacy against spruce budworm larvae, in these experiments. Undiluted Dipel^R 16L is recommended for further development and registration for the control of spruce budworm larvae.

Submitted for presentation in the Eighteenth Annual Forest Pest Control Forum to be held at the Government Conference Centre, Ottawa, November 20-22, 1990.

Distribution des gouttelettes et efficacité des formulations de Dipel^{R} non diluées appliquées à l'aide du Micronair AU4000 pour lutter contre les larves de la tordeuse des bourgeons de l'épinette

Afin d'optimiser l'efficacité des épandages aériens de Bacillus thuringiensis (B.t.) contre les larves de la tordeuse des bourgeons de l'épinette (Choristoneura fumiferana (Clem.)), des formulations huileuses non diluées et concentrées de Dipel^{R} ont été utilisées en 1988 et 1989 lors d'essais sur le terrain. Le Dipel^{R} 12L et le Dipel^{R} 16L, à une concentration de 25,4 et 33,8 MUI/L respectivement ont été appliqués à ultra-ultra-bas volume à raison de 15 et 30 MUI/ha dans 0,4, 0,55 et 1,1 L/ha à l'aide de deux Cessna 188 équipés de quatre Micronair AU4000. Des colorants orangés Day Glo ont été utilisés pour suivre et évaluer le dépôt des gouttelettes.

Au moment des pulvérisations de B.t., le microhabitat de la tordeuse des bourgeons de l'épinette dans le sapin baumier (Abies balsamea (L.) Mill.)) se compose principalement de soie tissée par les larves et des nouvelles aiguilles des jeunes pousses en développement et, quelquefois, des aiguilles d'un an. Les larves attachent ensemble les aiguilles des jeunes pousses à l'aide de soie afin de se faire un abri ou un nid où elles vivent. À ce stade, elles se nourrissent surtout des aiguilles à l'intérieur de l'abri. Les sétules et autres parties de la larve restent en contact constant avec la soie du microhabitat.

Afin d'améliorer l'efficacité du B.t., un insecticide d'ingestion, il est essentiel de déterminer les caractéristiques des gouttelettes atteignant les sites d'alimentation des larves. Les dépôts de gouttelettes ont été mesurés sur des cartes Kromekote^{R}, des simulateurs de feuillage, des aiguilles naturelles, de la soie de microhabitats et des dispositifs artificiels en forme de harpe confectionnés à l'aide de soies de larves afin de déterminer le spectre de grosseur des gouttelettes déposées dans les parcelles et les endroits cibles et sur la soie produite par la tordeuse des bourgeons. En 1988, du Dipel^{R} 12L a été appliqué à une concentration de 15 et 30 MUI/ha dans 0,55 et 1,1 L/ha respectivement. La tendance de dépôt moyen sur les aiguilles d'un an et de l'année en cours lors des traitements à 15 et 30 MUI était normale, c.-à-d., plus la dose était élevée, plus le dépôt était important. Toutefois, la tendance de dépôt moyen sur la soie du microhabitat était inverse. Un plus grand nombre de gouttelettes par microhabitat s'étaient déposées à 15 MUI qu'à 30 MUI en raison du plus grand nombre et de la fréquence plus élevée de gouttelettes plus petites (moins de 35 m). En 1989, du Dipel^{R} 16L a été appliqué à raison de 0,4 L/ha pour une concentration de 15 MUI et à raison de deux fois 0,4 L/ha dans le cas de 30 MUI. Le débit de 2 L/min/buse a été gardé constant afin d'obtenir un spectre de gouttelettes similaire. Le dépôt a été mesuré sur des soies produites par des larves et fixées à des dispositifs en forme de harpe, sur des aiguilles de l'année en cours et sur des aiguilles d'un an dans la parcelle ayant reçu une concentration de 30 MUI. Environ 42 % des gouttelettes des échantillonneurs en forme de harpe étaient inférieures à 10 m et 80 % étaient plus petites que 40 m.

Des caméros vidéo ont servi à étudier l'interaction entre les larves et les gouttelettes et les mécanismes intervenant dans le transfert du B.t. dans les sites d'alimentation. La toxicité résiduelle du spectre produit par les applications de 15 et 30 MUI des deux formulations a été étudiée et les effets des paramètres météorologiques ont été évalués. Le volume plus faible, la plus forte concentration de matière active et une meilleure pulvérisation de la formulation de Dipel^R^ 16L a amélioré la toxicité résiduelle et, par conséquent, l'efficacité de l'insecticide contre les larves de la tordeuse des bourgeons de l'épinette lors de ces expériences. Il est recommandé de poursuivre la mise au point du Dipel^R^ 16L non dilué à des fins d'homologation pour la répression des larves de la tordeuse des bourgeons de l'épinette.

Soumis à des fins de présentation lors du XVIII^e^ Forum annuel sur la répression des ravageurs forestiers qui se tiendra au Centre des conférences, à Ottawa, du 20 au 22 novembre 1990.

I. Forest Insect and Disease Status and Control Operation Summaries/Renseignements d'actualité sur les insectes et les maladies des arbres et résumés des activités de répression

THE SPRUCE BUDWORM IN NEWFOUNDLAND IN 1990

by

Raske, A.G., K.P. Lim and L.J. Clarke
Forestry Canada
Newfoundland and Labrador Region, St. John's, Newfoundland

Larval Development and Defoliation - The area of the infestation in the Codroy Valley in southwestern Newfoundland nearly tripled from 744 ha of moderate and severe defoliation in 1989 to 2 200 ha in 1990 (Fig. 1). The area of light defoliation also increased from 66 ha in 1989 to 900 ha in 1990. This infestation has persisted since the collapse of the outbreak in 1981. Several small infestations, that had persisted in the same Region since the collapse of the outbreak in 1981, and active in 1989, have decreased to endemic levels.

Control Program - There was no experimental or operational control program against the spruce budworm in 1990.

Biological Mortality Factors - Data on mortality factors were collected from an endemic population on the Baie Verte Peninsula, and from the infestation in western Newfoundland. The larvae (n = 28) of the endemic population sustained 50% parasitism and 4% were infected with the yeast-like organism (YLO). The YLO appears to be polymorphic and may comprise more than one species. Only 4.5% of the larvae (n = 156) collected in the infestation were parasitized.

Moths Caught in Pheromone-baited Traps - Pheromone traps were placed at 50 permanent sample location throughout the Island. The total number of moths decreased from 3 130 in 1989 to 1 452 in 1990. The highest numbers trapped were along the west coast of the Island. The trap location with the highest numbers were Campbells Creek with 785 moths and Sally's Cove with 266 moths. Almost all of these moths were probably transported to Newfoundland by warm air masses from the Maritime Provinces. Traps near the infestation at Codroy Pond caught 149 moths. Traps in central Newfoundland usually caught no moths, but the number of moths trapped at four locations ranged from one to five. More than 10 moths per trap site were caught in eastern Newfoundland for the first time since the trapping program began in 1985. A total of 36 moths were trapped near Clarenville and 14 and 10 moths were trapped at two locations on the Avalon Peninsula.

Forecast of Spruce Budworm Defoliation for 1990 - Overwintering populations were sampled in conjunction with the hemlock looper and blackheaded budworm egg sampling from mid- to late October, and a forecast will be prepared when the samples have been processed.

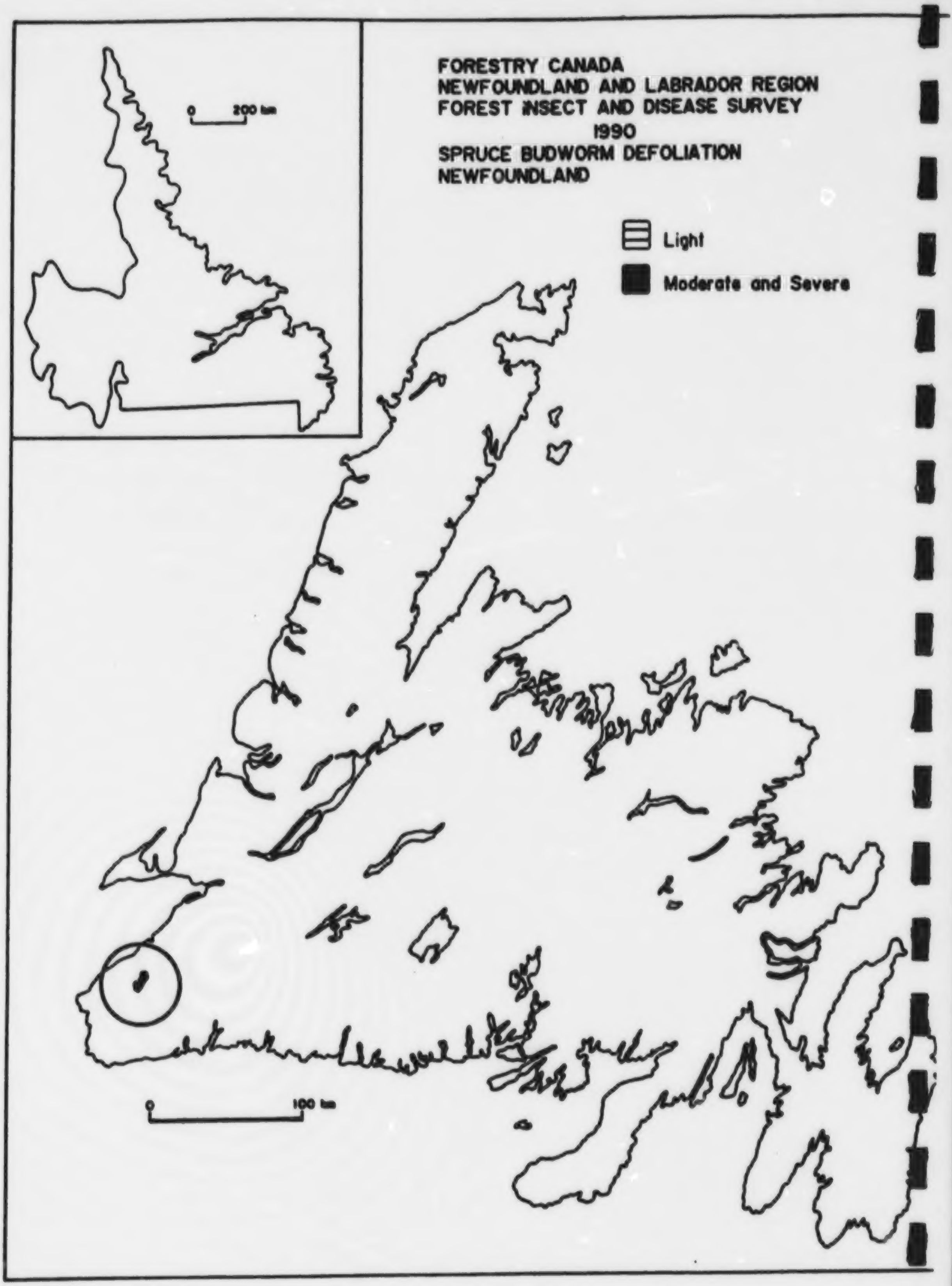
FORESTRY CANADA
NEWFOUNDLAND AND LABRADOR REGION
FOREST INSECT AND DISEASE SURVEY
1990
SPRUCE BUDWORM DEFOLIATION
NEWFOUNDLAND
▤ Light
■ Moderate and Severe
0 200 km
0 100 km

Fig 1. Areas of defoliation caused by the spruce budworm in Newfoundland in 1990.

THE HEMLOCK LOOPER IN NEWFOUNDLAND IN 1990

by

Raske, A.G., K.P. Lim and L.J. Clarke
Forestry Canada
Newfoundland and Labrador Region, St. John's, Newfoundland

Larval Development and Defoliation - A late and wet spring delayed larval hatch and early larval development, and probably decreased early larval survival in the main outbreak on the Northern Peninsula. A variable and sometimes large proportion of eggs collapsed in spring and failed to hatch. Localized and small areas of infestation continued to cause moderate and severe defoliation on the Avalon Peninsula. But the largest areas of defoliation occurred on the Northern Peninsula where 2 550 ha of moderate and severe defoliation occurred (Table 1, Fig. 1); compared to 7 900 ha in 1989. The total area of moderate and severe defoliation decreased in size and the density of looper populations within infested areas was also generally lower. This was caused in part by the failure of many larvae to hatch and by the control program.

Control Program - The Department of Forestry and Agriculture treated about 13 000 ha of the infestation with *B.t.* on the Northern Peninsula.

Biological Mortality Factors - Endemic populations on the Northern Peninsula were sampled weekly in 1990, and eight larvae and three pupae were collected on 840 branches. Of these larvae three were parasitized and three were infected with a yeast-like organism. Larvae (n = 280) were collected for parasite rearing from infestations on the Avalon Peninsula and 2.5% of these were parasitized by tachinids. However, populations of several small infestations on the Avalon were greatly reduced by fungal diseases.

Forecast of Hemlock Looper Defoliation for 1990 - Overwintering egg numbers were sampled from mid- to late October, and a forecast will be prepared when the samples have been processed.

Table 1. Areas (ha) of defoliation caused by the hemlock looper in productive forests of Newfoundland in 1990.

Management Unit No.	Defoliation Class			Total
	Light	Moderate	Severe	
1	300	300	100	700
17	400	-	50	450
18	12 600	600	1 500	14 700
Total	13 300	900	1 650	15 850

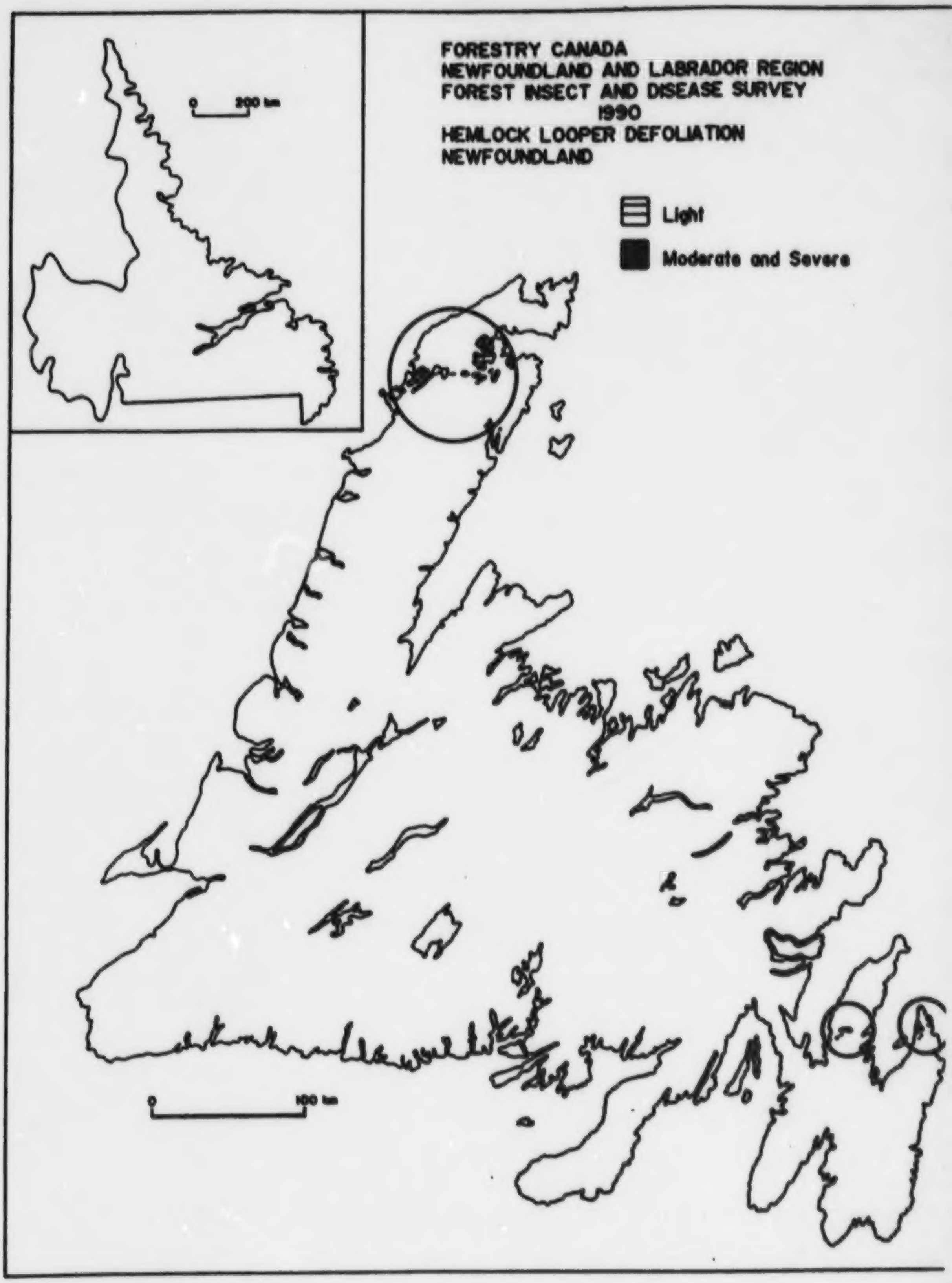
FORESTRY CANADA
NEWFOUNDLAND AND LABRADOR REGION
FOREST INSECT AND DISEASE SURVEY
1990
HEMLOCK LOOPER DEFOLIATION
NEWFOUNDLAND
▤ Light
■ Moderate and Severe
0
200 km
0
100 km

Fig. 1. Areas of defoliation caused by the hemlock looper in Newfoundland in 1990.

THE BLACKHEADED BUDWORM IN NEWFOUNDLAND IN 1990

by

Raske, A.G., K.P. Lim and L.J. Clarke*

Larval Development and Defoliation - The present outbreak of the blackheaded budworm started in 1987 and expanded to 35 000 ha of balsam fir forests on the Northern Peninsula. Moderate and severe defoliation occurred mainly in overmature stands, with some light defoliation in pre-commercially thinned stands. Larval parasitism was only 24% and the outbreak was expected to continue in 1990. In several areas of the outbreak this budworm fed in association with the hemlock looper and both insects contributed to tree mortality.

In 1990 the outbreak continued in the same general area as in 1990, and 7 450 ha sustained moderate and severe defoliation and an additional 14 400 ha of defoliation was classed as light (Table 1, Fig. 1).

Control Program - Forestry Canada in cooperation with the Newfoundland Department of Forestry and Agriculture tested B.t. for efficacy against the blackheaded budworm. The results are presented later in this report.

Biological Mortality Factors - In 1990 populations were sampled in the outbreak area on the Northern Peninsula and low populations were sampled on the Baie Verte Peninsula.

On the Northern Peninsula about 1% of the eggs collected (n = 102) were infected with a protozoan tentatively identified as Mattesia sp. (Neogregarinidae). Of the larval samples (n = 657) about 10% were parasitized by insects, 2% were killed by fungi, Paecilomyces farinosus and

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* Forestry Canada, Newfoundland and Labrador Region, St. John's, Newfoundland.

Entomophthorales, and 5% were infested with yeast-like organisms. About 5% of the pupae (n = 340) were parasitized. A total of 328 larvae were collected by FIDS staff and 14.3% of these were parasitized.

On the Baie Verte Peninsula about 11% of the larvae sampled (n = 125) were parasitized and about 2% were infected with yeast-like organisms.

Forecast of Blackheaded Budworm Defoliation for 1991 - Overwintering egg numbers were sampled from mid- to late October, and a forecast will be prepared when the samples have been processed.

Table 1. Areas (ha) of defoliation caused by the blackheaded budworm in productive forests of Newfoundland in 1990.

Management Unit No.	Defoliation Class			Total
	Light	Moderate	Severe	
17	6 300	4 100	1 800	12 200
18	8 100	1 400	150	9 650
Total	14 400	5 500	1 950	21 850

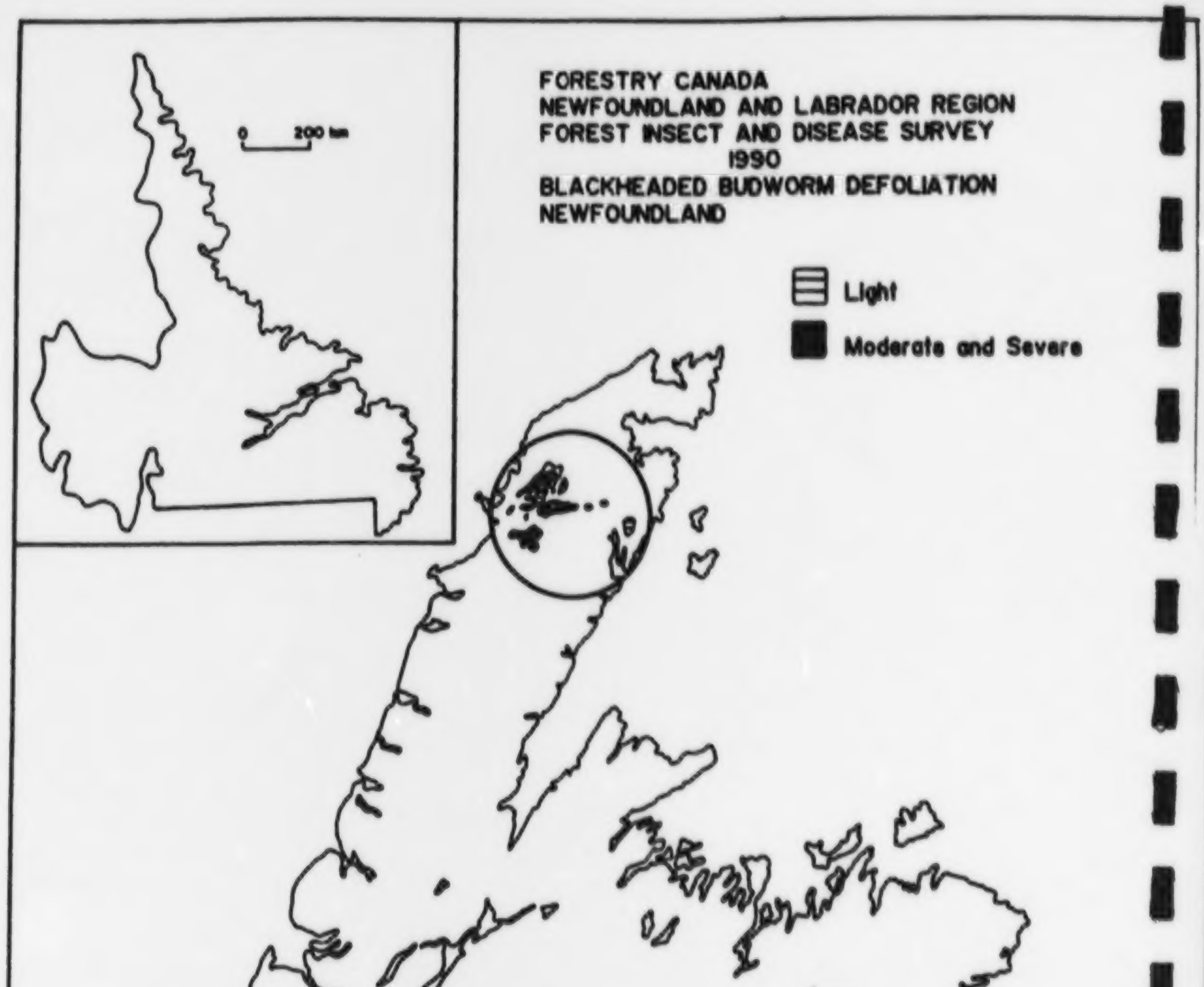
FOREST INSECT AND DISEASE SURVEY
FORESTRY CANADA
NEWFOUNDLAND AND LABRADOR REGION
1990
BLACKHEADED BUDWORM DEFOLIATION
NEWFOUNDLAND
Light
Moderate and Severe
0
200 km
0
100 km

Figure 1. Areas of defoliation caused by the blackheaded budworm in Newfoundla in 1990.

THE BALSAM WOOLLY ADELGID IN NEWFOUNDLAND IN 1990

by

Raske, A.G. and W.W. Bowers *

The balsam woolly adelgid is one of the three most important forest insect pests in insular Newfoundland. Since its accidental introduction in to the Province in the 1930s, the adelgid has caused considerable damage and tree mortality in many stands in western areas of the Island.

At present population levels are increasing and populations are spreading to other areas of the Island. Of special concern is the increase of this adelgid in managed stands that have been thinned or are scheduled for thinning. Some of these managed stands have been damaged, and surveys of active infestations have established base-line population data for such stands.

Experimental applications of insect growth regulators (IGRs) to adelgid-infested trees reduced populations of sessile nymphs, but further investigations into their use for control may not be warranted because efficacy was unacceptable.

In the fall of 1989 FIDS initiated a survey of adelgid populations throughout the Island. About half of the Island has been surveyed and in western and central Newfoundland the following results were obtained: 1) High populations of more than 10 adelgids/node occurred in isolated pockets in five areas in central Newfoundland, and in three areas in western Newfoundland (Fig. 1). The highest population level was 35 adelgids/node in the Goose Arm River Valley. 2) Moderate populations of

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*Forestry Canada, Newfoundland and Labrador Region, St. John's, Newfoundland.

5 to 9 adelgids/node occurred in two additional areas. 3) Low populations of 0.1 to 4.9 adelgids/node occurred in numerous stands scattered in most of the areas surveyed to date (Fig. 1). 4) No adelgids occurred on the Northern Peninsula, north of Gros Morne National Park, in the 70 locations sampled.

Central and eastern areas of the Island will be surveyed in 1990 and the samples processed in early 1991.

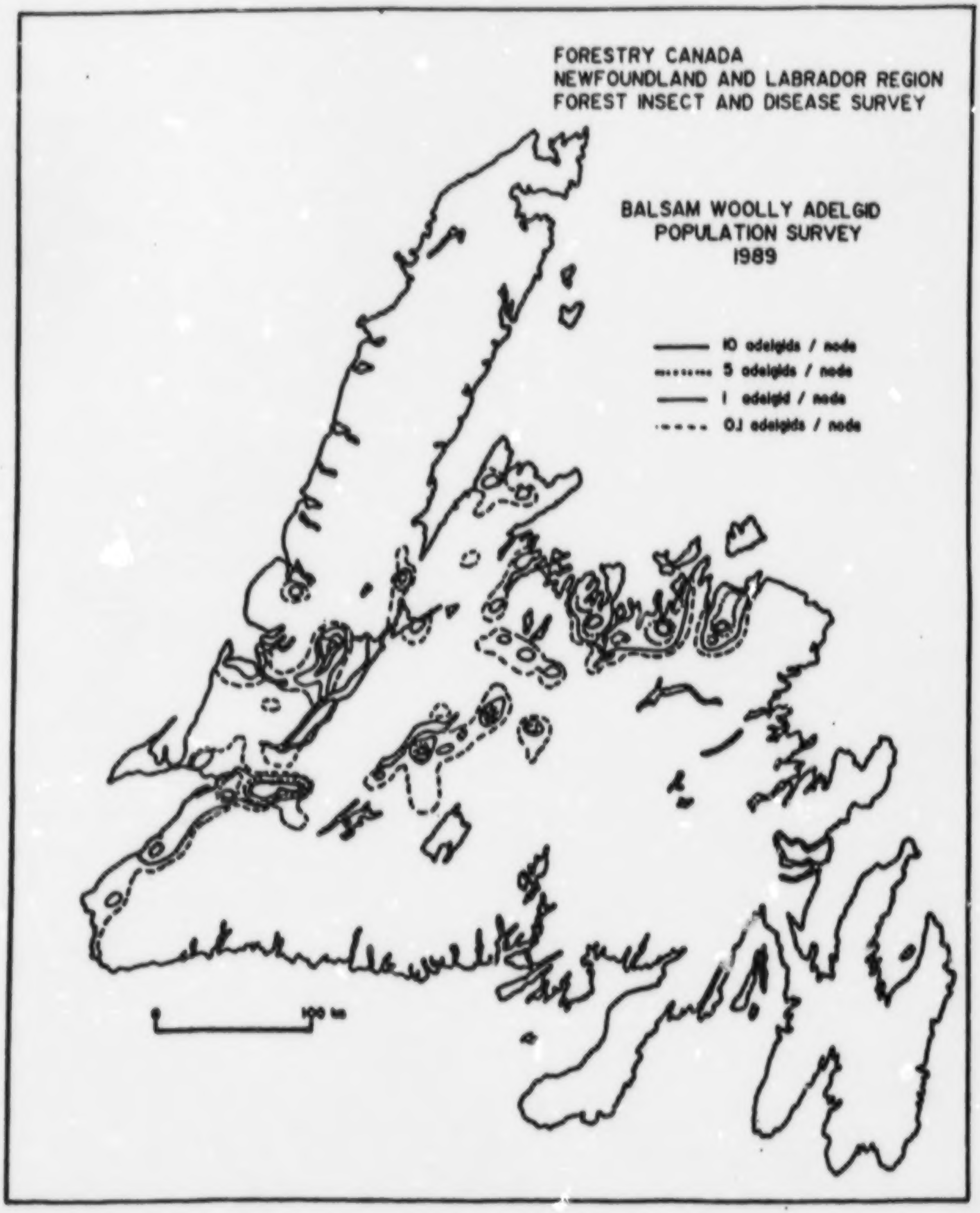
FORESTRY CANADA
NEWFOUNDLAND AND LABRADOR REGION
FOREST INSECT AND DISEASE SURVEY
BALSAM WOOLLY ADELGID
POPULATION SURVEY
1989
10 adelgids / node
5 adelgids / node
1 adelgid / node
0.1 adelgids / node
0
100 km

Fig. 1. Population densities of the balsam woolly adelgid in western and north-central Newfoundland in 1989.

THE SCLERODERRIS CANKER IN NEWFOUNDLAND IN 1990

by

Warren, G.R. and G.C. Carew *

Scleroderris canker was first recorded in Newfoundland in 1979 on Austrian pine trees near St. John's, and now occurs sporadically throughout the city. A severe outbreak of the disease occurred in 1981 in a 2 ha red pine plantation north of St. John's at Torbay. All plantation trees were cut and burned and no further signs of the disease have been found at this site. In 1982 infected ornamental Scots pine, jack pine and red pine were found infected along Salmonier Line 30 km west of St. John's. Diseased trees were cut and burned.

In 1985 a Sitka spruce plantation on the Northern Peninsula was found to be infected with Scleroderris canker. Sanitation procedures of pruning or cutting and burning of diseased material appeared to control the disease until inspections in 1990 showed a reoccurrence of damage on some trees. Numerous plantations were established across the Island with the same Sitka spruce planting stock. In 1987 efforts were made to locate all of these plantations. To date 19 additional plantations have been identified, inspected and found free of the disease (Fig. 1).

In 1987 Scots pine in an old abandoned nursery on Salmonier Line had severe foliar damage caused by Scleroderris canker. Previous inspections of this site had showed no signs of this disease. Seedling stock from this nursery was used to establish 16 plantations throughout eastern Newfoundland. Inspections of these sites found the disease present at only one plantation, Colliers Ridge west of St. John's.

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*Forestry Canada, Newfoundland and Labrador Region, St. John's, Newfoundland.

In 1990 both the tree nursery and this plantation continued to show symptoms of the disease. Infection in and around St. John's in 1990 continued but the incidence was lower than in previous years. Infected trees were pruned.

Fungal isolates from diseased trees were tested by elecrophoresis for race determination. Isolates from pines in Newfoundland have been identified as the European race of *Gremmeniella abietina* (Lagerb.) Morelet var. *abietina*, and isolates from Sitka spruce as *G. abietina* var. *balsamea*, a different race. Research is planned, in cooperation with the Quebec Region, to study the etiology of Scleroderris canker in Newfoundland.

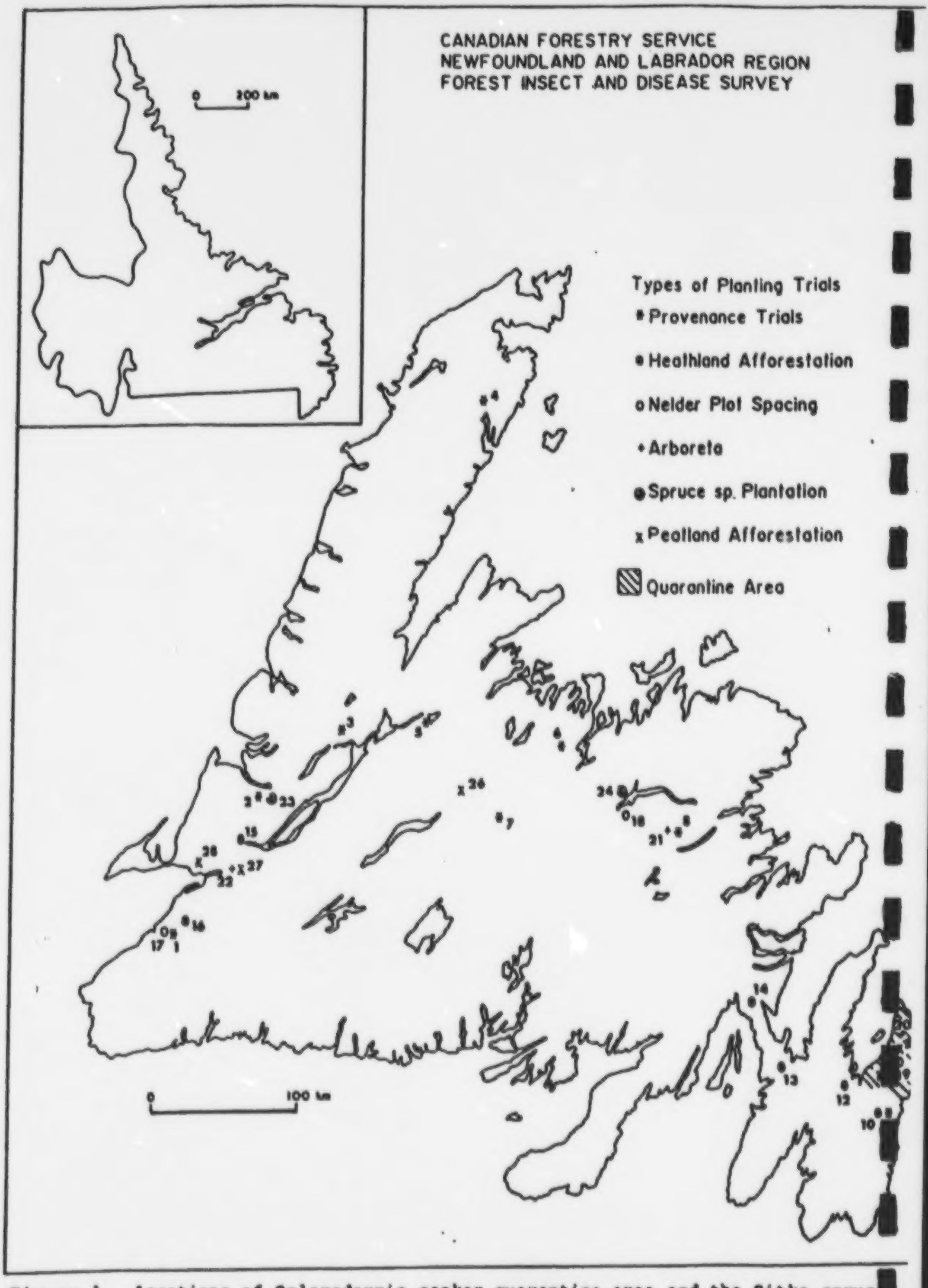
CANADIAN FORESTRY SERVICE
NEWFOUNDLAND AND LABRADOR REGION
FOREST INSECT AND DISEASE SURVEY
0
200 km
Types of Planting Trials
* Provenance Trials
● Heathland Afforestation
○ Nelder Plot Spacing
+ Arboreta
◉ Spruce sp. Plantation
x Peatland Afforestation
▨ Quarantine Area
0
100 km
4
3
5
6
2
23
26
7
15
28
27
22
16
17
1
24
18
8
21
14
13
12
10
9

Figure 1. Locations of Scleroderris canker quarantine area and the Sitka spruc experimental plantations in Newfoundland using seedlings from Acadia Forest Nursery, N.B.

THE BALSAM FIR SAWFLY IN NEWFOUNDLAND IN 1990

by

Raske, A.G. and L.J. Clarke*

The balsam fir sawfly is the name of a species complex whose members feed predominantly on fir and occasionally on spruce. This insect was first collected in Newfoundland in the mid 1930s, and the first recorded outbreak occurred in 1947. The preferred host in Newfoundland is balsam fir although white and black spruce may also be severely defoliated during outbreaks. Only foliage of old growth is consumed giving severely defoliated trees a characteristic tufted appearance. This feeding causes little damage and tree mortality usually occurs only in conjunction with damage by other insects, such as the spruce budworm, blackheaded budworm, hemlock looper or the balsam woolly adelgid.

In Newfoundland and Labrador several outbreaks have occurred during the last three decades, and the longest outbreak occurred in western Newfoundland from 1950 to 1976. The outbreak fluctuated within this region, and high populations did not persist in any one locality. In 1973 an outbreak of this sawfly and of the blackheaded budworm was recorded in 8 000 ha of mature balsam fir in Labrador near Sandwich Bay. From 1977 to 1988 populations were generally at endemic levels except for a few local and short-lived infestations. Parasites apparently are mainly responsible for reducing high population levels of the balsam fir sawfly.

In 1989 population levels were extremely high along several rivers in the Bay d'Espoir area on the south coast of Newfoundland. Stands of stunted old-growth fir were most often infested, but some vigorous young stands were also severely defoliated. About 1 300 ha were moderately and severely defoliated and another 110 ha was lightly defoliated.

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* Forestry Canada, Newfoundland and Labrador Region, St. John's, Newfoundland.

In 1990 the size of the infestation increased to 6 200 ha (Fig. 1), and 3 800 ha was classed severe. The infestation expanded into several river valleys in the Bay d'Espoir area and strips of coastal forest. Parasitism within the infested areas was low at less than 1%.

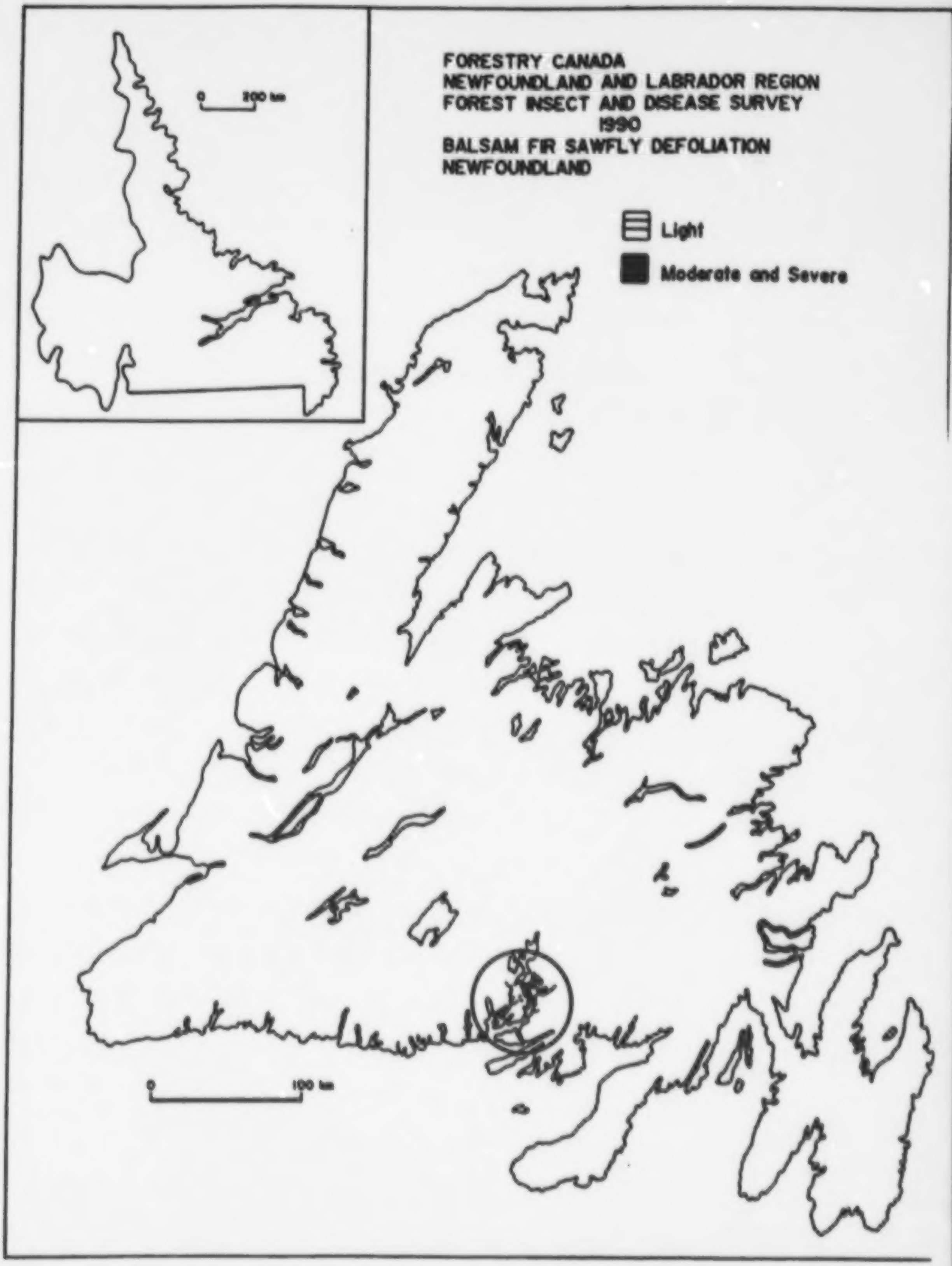
FORESTRY CANADA
NEWFOUNDLAND AND LABRADOR REGION
FOREST INSECT AND DISEASE SURVEY
1990
BALSAM FIR SAWFLY DEFOLIATION
NEWFOUNDLAND
▤ Light
■ Moderate and Severe
0 200 km
0 100 km

Fig. 1. Areas of defoliation caused by the balsam fir sawfly in Newfoundland in 1990.

EFFICACY OF B.t. APPLICATIONS AGAINST THE BLACKHEADED BUDWORM IN NEWFOUNDLAND IN 1990

R.J. West and J. Carter

Forestry Canada, Newfoundland and Labrador Region, St. John's, Newfoundland

Abstract

Oil- and water-based formulations of *Bacillus thuringiensis* (*B.t.*), Dipel 176 and Futura SLV, were applied twice at a rate of 30 Billion International Units (BIU) per ha over four 45-ha plots in a balsam fir forest in efficacy trials against the eastern blackheaded budworm, *Acleris variana* (Fern.). Spray coverage was excellent with deposits averaging over one droplet/needle. Population reductions 10 days after the second application ranged from 52 to 94% for Dipel 176 and 84 to 85% for Futura. Analysis of upper-crown samples indicated current-year foliage savings of 0 to 19% for the Dipel treatments and 8 to 50% for the Futura treatments. Whole-tree estimates of current-year defoliation indicated that no foliage was saved in the plots treated with Dipel and that savings of only 1 to 7% resulted from the treatments with Futura. The lack of efficacy was attributed to the feeding behaviour of larvae; the blackheaded budworm feeds within buds and is less likely to ingest a lethal dose of *B.t.* than a defoliator that feeds openly.

Outbreaks of the eastern blackheaded budworm, *Acleris variana* (Fern.), periodically occur in balsam fir forests in eastern

Canada. The present outbreak in Newfoundland is located on the Northern Peninsula and has caused severe defoliation in mature stands of balsam fir since it began in 1987. Egg surveys by the Forest Insect and Disease Survey indicated that 89,000 ha would be severely defoliated in 1990. The continuation and severity of this outbreak demands the consideration of control measures but no insecticide is currently registered for operational use against the blackheaded budworm. To provide efficacy data for product registration, Forestry Canada and the Newfoundland Department of Forestry and Agriculture cooperated to field-test formulations of *Bacillus thuringiensis* (*B.t.*) currently used operationally to control populations of the hemlock looper.

Double applications of Dipel 176 and Futura XLV at 30 BIU/ha were made from a Grumman AgCat aircraft equipped with six Micronair AU4000 atomizer units. Two 45-ha test plots were used to evaluate the efficacy of each formulation. An untreated area was used as a control plot. The first application was on 13 July when larval development was 3% first instars, 60% second instars and 37% third instars. The second application was on 21 July when larval development was 51% third instars, 41% fourth instars and 8% fifth instars. Applications were made between 0530 and 0730 hours.

Weather The applications were made under windy, humid, and dry conditions with air stability neutral to inversion in status. The rain-free periods following spraying were 48 h for the first application and 12 h for the second application.

Spray Deposit Spray coverage was excellent with an average of over one droplet/needle on upper crown branches.

Population Reduction Prespray counts on upper-crown branch samples indicated high population levels and ranged from 33-75 larvae/100 buds with 31-62% of current-year buds attacked.

Dipel 176: Larval numbers decreased by 4-23% five days after the first application and by 16-89% after the second application in the treated plots (Table 1). Population reductions from treatment ranged from 52-94%.

Futura XLV: Larval numbers decreased by 55% in one plot and doubled in the other plot five days after the first application (Table 1). Larval numbers decreased by 72-74% after the second application. Population reductions from treatment ranged from 84-85%.

Defoliation There was no apparent protection five days after the first application. Foliage savings as determined from upper-crown foliage sampled 10 days after the second application ranged from 8-50% for the Futura treatments and 0-19% for the treatments of Dipel (Table 2). Whole-tree estimates of defoliation indicated no foliage saved in the plots treated with Dipel and only 1-7% foliage saved in the plots treated with Futura (Table 3).

CONCLUSIONS:

Neither Dipel 176 nor Futura XLV were very effective in protecting balsam fir foliage from defoliation despite excellent spray deposits of over one droplet/needle. Deposits as high as this protect well against the hemlock looper, an open feeder. The blackheaded budworm feeds within needles matted together with silk and frass and is less likely to encounter enough spray droplets to cause mortality.

B.t. applications targeted against immature larvae did not reduce damage after the first application, but reductions in the numbers of mature larvae after the second application provided some protection in 3 of the 4 treated plots. This protection, however, is insufficient to warrant the operational use of *B.t.* applied at 30 BIU/ha against the blackheaded budworm. More potent formulations of *B.t.* applied at higher doses may be worth testing.

Table 1. Effect of double applications of Bacillus thuringiensis o larval populations of the black-headed budworm near Plu Point, Newfoundland, in 1990.

Treatment/ plot	Larvae/100 buds (x±SE)			Reduction (%)	
	Pre-1st spray	Pre-2nd spray	Post-spray	Pre-2nd spray	Post-spray
Dipel 176/1	75.7±8.4	72.3±10.6	8.0±3.8	38.1	93.9
Dipel 176/2	43.7±17.0	33.7±3.9	36.7±7.2	50.2	51.8
Futura XLV/1	49.5±15.4	102.0±13.1	14.1±5.6	0	83.6
Futura XLV/2	65.8±5.7	29.5±7.5	16.8±3.8	70.9	85.4
Control	32.9±3.9	50.6±9.2	57.2±8.9		

Table 2. Current-year defoliation on upper-crown branches of balsam fi and foliage saved in plots infested by the blackheaded budwor and treated with Bacillus thuringiensis near Plum Point, Newfoundland, in 1990.

Treatment/ plot	Defoliation/branch (%)			Foliage saved (%)	
	9 July	17 July	31 July	17 July	31 July
Dipel 176/1	10.2	35.9	68.6	0	0
Dipel 176/2	3.5	14.0	39.4	0	18.6
Futura XLV/1	4.5	28.0	44.7	0	7.7
Futura XLV/2	6.4	21.4	24.5	0	49.5
Control	3.6	12.6	48.5		

Table 3. Whole-tree estimates of current-year defoliation of balsam fir in plots treated with B.t. formulations near Plum Point, Newfoundland in 1990.

Treatment/ plot	Defoliation/tree (x±SE)	Foliage saved (%)
Dipel 176/1	61.0±4.4	0
Dipel 176/2	50.7±4.9	0
Futura XLV/1	44.7±5.2	1.3
Futura XLV/2	42.0±6.4	7.3
Control	45.3±6.7	

INSECT CONTROL PROGRAMS IN NEWFOUNDLAND IN 1990

by H. Crummey

(Prepared for the 18 th Annual Forest Pest Control Forum
Ottawa, Ontario - November 20 - 22, 1990)

BLACK ARMY CUTWORM

As was the case in 1989, low numbers of cutworm larvae were identified at several newly planted sites, but because of adequate alternate vegetation and the absence of any significant feeding on the black spruce seedlings, the decision was made to forego any control program in 1990.

It is anticipated that the cutworm will be present at several sites again in 1991. These will be closely monitored in the spring and control will be initiated as required.

SPRUCE BUDWORM

The Forestry Canada forecast for 1990 indicated that a total of 18 733 hectares (ha) were expected to be defoliated, with 3 127 ha in the moderate and severe defoliation class. However, because of the locations of these infestations, no control program was proposed.

The 1990 defoliation survey conducted by Forestry Canada determined that 3 100 ha were affected with 2 200 ha in the moderate to severe defoliation category.

The forecast for 1991 is not yet available. Branch samples were collected in mid-October and processing will be completed by the end of this year. The results will form the basis of whether or not a control program will be required in 1991.

HEMLOCK LOOPER

This is the seventh year of the present hemlock looper outbreak in insular Newfoundland. The 1990 forecast indicated an expected total infested area of approximately 69 100 ha with 55 400 ha in the moderate and severe category, mainly in northwestern Newfoundland from Castors River to Main Brook. This forecast included 46 500 ha in overlap of both hemlock looper and blackheaded budworm.

Based on this forecast, Government approved an operational spray program for 1990 using the biological insecticide, B.t. to combat the looper, and to test several areas with B.t. against the blackheaded budworm. All treatment blocks were to receive two applications of B.t., at 30 BIU per hectare per application, about four (4) to six (6) days apart. The revised proposed program consisted of approximately 35 000 hectares (thirty-two (32) spray blocks) of predicted moderate to severe defoliation and some predicted light defoliation in silviculture areas. All proposed areas were situated on the Great Northern Peninsula, between Castors River and Forresters Point on the western side of the Peninsula, and east across the Peninsula with spray blocks near Main Brook and Roddickton. In addition, surrounding areas were to be monitored to determine population levels and to assess if treatment of these would be necessary.

Monitoring of insect population levels was carried out prior to spraying to determine where and when areas were to receive treatment. It was determined that the level and extent of the looper population was not as forecast. Forestry Canada indicated that this decline in the population was likely to have resulted from the cool, wet spring and the subsequent failure of the larvae to hatch. The net result was that a total of eleven (11) blocks (approximately 9 200 hectares) received two (2) applications of B.t., and one (1) block (approximately 800 hectares) received one (1) application of B.t. for looper control, and one (1) block (approximately 1 000 hectares) received two (2) applications and two (2) blocks (approximately 1 400 hectares) received one (1) application of B.t. to test against the blackheaded budworm.[Figure 1, Table 1]. The remaining seventeen (17) blocks (approximately 22

000 hectares) were monitored for insect populations, but were not treated because of very low insect numbers. All blocks were treated with the biological insecticide B.t.(Futura XLV) except for one (1) block (Block 213) which was treated with the B.t. product Foray 48B for comparison.

Spray aircraft consisted of four (4) single-engine, fixed-wing AgCats, contracted from Agric Air Inc. of Quebec, and equipped with Micronair spray atomizers (three were equipped with AU5000s and one with AU4000s - the latter being used for experimental spraying in co-operation with Forestry Canada). In addition, one (1) helicopter and a twin-engine fixed-wing aircraft provided navigation and supervision support for the program. Spray operations were based out of airstrips at Main Brook, on the east side of the Northern Peninsula , and Sandy Cove, on the west side.

The program was scheduled to commence in early July, but as a result of the late spring, insect hatching was delayed. Operations began on July 15 and ended on August 6. The program ran quite well, although there were some delays experienced due to poor spray weather.

Intensive sampling in the proposed spray areas in late June indicated that the looper population was patchy in distribution, and generally low throughout, although there were pockets of high population. However, the blackheaded budworm was detected in most of the treated blocks. This insect is usually ten (10) days to two (2) weeks earlier than the hemlock looper, and so are actively feeding on the new foliage by the time of looper hatch.

Pre-spray and post-spray data collected from spray blocks and check area were used to determine hemlock looper population levels and percent defoliation to judge the effectiveness of the control program. The average number of looper larvae per sample unit per plot for all treated areas was about seventy-six (76) (n=19, range

23 to 196) with the higher count sufficient to cause moderate to severe defoliation). The average number of looper larvae per sample unit per plot in the untreated 'check' areas was about thirty-three (33) (n=6, range 19 to 49). This variability between plots is not unusual with the looper, more so during a declining outbreak when numbers can vary greatly. Prior to spraying, estimates of tree defoliation of current years needles averaged about eight percent (8 %) (range 3 to 25 %) for treated blocks and about five percent (5 %) (range 0 to 6 %) for untreated areas. The corresponding figures for the older foliage in treated and untreated areas were about three percent (3 %) (range 0 to 9 %) and one percent (1 %) (range 0 to 4 %). As mentioned, the blackheaded budworm occurred in most blocks, but it is unknown what proportion of the observed pre-spray defoliation could be attributed to budworm and what proportion to the looper.

After treatment, the uncorrected mortality of looper larvae averaged about twenty-six percent (26 %) (range 0 to 77 %) for treated blocks and about nineteen percent (19 %) (range 0 to 35 %) for untreated areas after the first application, and averaged about eighty-one percent (81 %) (range 0 to 99 %) in treated and about forty-seven percent (47 %) (range 0 to 95 %) in untreated areas after the second application. Population reduction due to treatment averaged about sixteen percent (16 %) (range 0 to 60 %) after the first application and about sixty-five percent (65 %) (range 0 to 99 %) after the second application.

Tree defoliation of current years growth after treatment averaged fourteen percent (14 %) (range 1 to 55 %) for treated and about seven percent (7 %) (range 2 to 10 %) for untreated areas after the first application. After the second application, the defoliation figures in treated and untreated areas were fifteen percent (15 %) (range 4 to 55 %) and eighteen percent (18 %) (range 4 to 52 %) respectively. Foliage protection (due to treatment) after the first application averaged about nineteen percent (19 %)

(range 0 to 100 %) and about forty-five percent (45 %) (range 0 to 100 %) after the second application.

Assessment of tree defoliation of older needles (other than current years needles) indicated that in treated areas, there was little defoliation after the first application and basically no difference after the second application. The average defoliation was about three percent (3 %) (range 0 to 13 %). In untreated areas, there was an increase in older needle defoliation mainly between the first and second applications, from about one percent (1 %) (range 0 to 4 %) pre-spray to about six percent (6 %) (range 0 to 21 %) post-spray.

An aerial survey conducted by the Department to assess the overall defoliation in and adjacent to the treated areas indicated that, on average, moderate to severe total tree defoliation occurred on about nine percent (9 %) (range <1 % to 17 %) of the treated area (Table 2). This survey indicated that moderate to severe defoliation was quite patchy and was more prevalent in and around blocks on the eastern side of the Northern Peninsula, even though these areas received treatment first.

The single block treated to test the B.t. product Foray 48B against the hemlock looper had results which did not differ greatly from those reported for Futura XLV.

The 1990 hemlock looper spray program was considered a qualified success in terms of reducing population levels and to a lesser extent in providing foliage protection. However, the overall levels of defoliation were not as great as in previous years due to lower population levels of the looper and to good, early tree growth. In summary, there were some inconsistencies in the data which could not be explained, but generally, where treatment was delayed and where the population was higher, the level of foliage protection was lower. The other factor which is suspected of influencing the results was the presence of blackheaded budworm larvae.

Forestry Canada have completed the 1990 defoliation survey which determined that 15 850 ha were affected with 2 550 ha in the moderate to severe defoliation category.

The forecast for 1991 will be available in early January. Any control options will be assessed once the forecast is received.

Blackheaded budworm

A forecast provided by Forestry Canada indicated that the blackheaded budworm would infest 91 400 ha on the Northern Peninsula with 89 400 ha in the moderate to severe defoliation category. Of the total forecast, some 46 500 ha were forecast to be defoliated due to a combination of both blackheaded budworm and looper.

As there are no registered products available for control of this insect, Forestry Canada, with co-operation from the Department of Forestry and Agriculture, carried out a number of experimental trials to test the effectiveness of two types of B.t. against the Eastern Blackheaded Budworm. These trials were carried out in conjunction with the operational part of the spray program and were situated in the Round Lake area of the Peninsula.

Two applications of 30 BIUs per hectare per application were applied to four 45-hectare blocks. Forestry Canada indicate, that spray deposit was good and post spray weather acceptable. Although budworm populations were reduced due to treatment (52 to 94 %) and foliage protection was from 0 to 50 % on branch samples, defoliation of current years foliage based on the whole tree only ranged from 0 to 7 %. Forestry Canada consider the ineffectiveness of B.t. against this pest to be due to the enclosed feeding habits of this insect.

The results of the experiments indicate that at this time, B.t. would appear not to provide an option for foliage protection, but could be used for population control.

The three blocks treated to test B.t. against the blackheaded budworm, and assessed under operational conditions, are still being analyzed. However, preliminary indications are that the results are similar to those obtained by Forestry Canada in their trials.

Forestry Canada have indicated that in 1990, 21 850 ha were defoliated with 7 450 ha in the moderate and severe categories.

The 1991 forecast should be available from Forestry Canada by the end of the year.

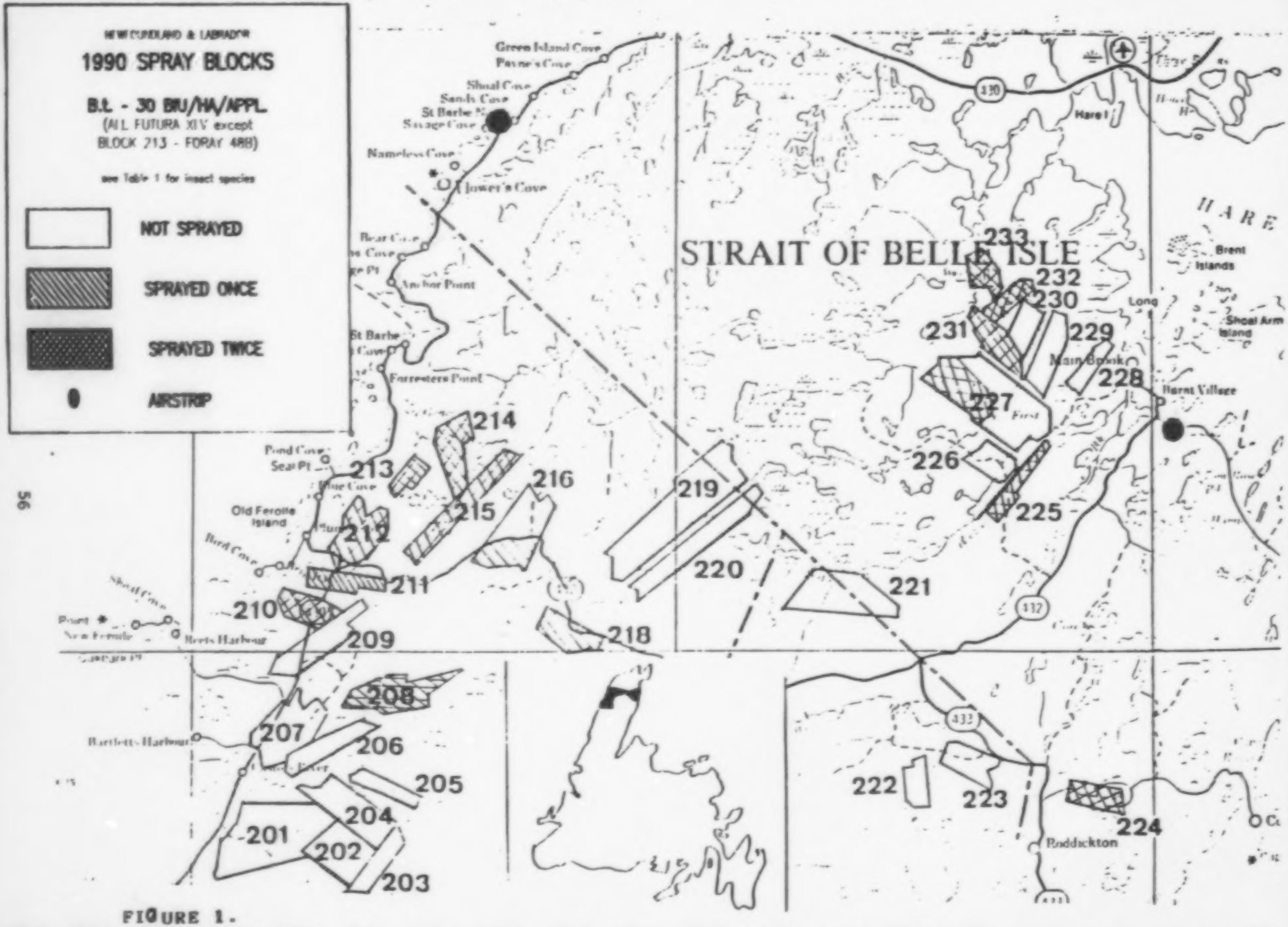
NEWFOUNDLAND & LABRADOR
1990 SPRAY BLOCKS
B.t. - 30 BIU/HA/APPL.
(ALL FUTURA XLV except
BLOCK 213 - FORAY 48B)
see Table 1 for insect species
NOT SPRAYED
SPRAYED ONCE
SPRAYED TWICE
AIRSTRIP
STRAIT OF BELLE ISLE
HARE
Green Island Cove
Payne's Cove
Shoal Cove
Sands Cove
St Barbe
Savage Cove
Nameless Cove
Flower's Cove
Bear Cove
Anchor Point
St Barbe
Forresters Point
Pond Cove
Seal Pt
Blue Cove
Old Ferolle Island
Bird Cove
Point New Ferolle
Reefs Harbour
Bartletts Harbour
Brent Islands
Shoal Arm Island
Long
Main Brook
Hare Bay
Roddickton
430
432
433
201
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FIGURE 1.

TABLE 1.

AREA TREATED IN 1990 INSECT CONTROL PROGRAM IN NEWFOUNDLAND

HEMLOCK LOOPER - B.t. - 30 BIU/Ha/Application

BLOCK #	LOCATION	BLOCK SIZE (HA)	AREA TREATED - ONE APPL.	AREA TREATED - TWO APPLS.	BLOCK HA FIRST + SECOND APPL.
208	Big Feeder Pond	1121		1121	1121
210	St. Margaret Bay	925		925	925
211	Brig Bay	816	816		816
212	Plum Point	1425		1425	1425
213	Genevieve River	433		433	433
214	Angle Pond	953		953	953
215	Ten Mile Lake	1014		1014	1014
225	Camp 16	730		730	730
227	First Salmon Pond	3192		1350	1350
231	West Brook South	962		962	962
232	West Brook Steady	442		442	442
233	West Brook Big Pond	445		445	445
		TOTAL	**816**	**9,800**	**10,616**

All Blocks treated with FUTURA XLV except Block 213 (FORAY 48B)

BLACKHEADED BUDWORM - FUTURA XLV - 30 BIU/Ha/Application

BLOCK #	LOCATION	BLOCK SIZE (HA)	AREA TREATED - ONE APPL.	AREA TREATED - TWO APPLS.	BLOCK HA FIRST + SECOND APPL.
216	Roses Feeder	1815	580		580
218	Tilt Pond	1106	796		796
224	Penny's Pond	1046		1046	1046
		TOTAL	**1,376**	**1,046**	**2,422**

TABLE 2.

AERIAL DEFOLIATION - HEMLOCK LOOPER SPRAY BLOCKS, 1990

HEMLOCK LOOPER

BLOCK #	LOCATION	TREATED BLOCK SIZE (HA)	AREA (Ha) DEFOLI-ATED. M.- S.*	% OF BLOCK M.-S. *	AREA (Ha) DEFOLI-ATED. S. *	% OF BLOCK S. *
208	Big Feeder Pond	1121	205	18 %		
210	St. Margaret Bay	925	35	4 %	5	<1 %
211	Brig Bay	816			5	<1 %
212	Plum Point	1425			10	<1 %
213	Genevieve River	433	16	4 %	10	2 %
214	Angle Pond	953	28	3 %	8	<1 %
215	Ten Mile Lake	1014	38	4 %	28	3 %
225	Camp 16	730	99	14 %		
227	First Salmon Pond	1350	68	5 %	102	8 %
231	West Brook South	962	47	5 %	85	9 %
232	West Brook Steady	442	25	6 %	48	11 %
233	West Brook Big Pond	445	8	2 %	75	17 %
	TOTAL	**10,616**	**569**	**5 %**	**376**	**4 %**

* M. - S. = Moderate to severe tree defoliation; S. = Severe tree defoliation

FOREST PEST CONDITIONS IN THE MARITIMES IN 1990

EIGHTEENTH ANNUAL FOREST PEST CONTROL FORUM
OTTAWA, ONTARIO
NOVEMBER 20-22, 1990

Significant forest pest conditions which occurred in the Maritimes Region in 1990 have been reeported in Forestry Canada - Maritimes Technical Notes 237, 238, 239, and 241. Copies of these are attached.

Insects discussed in some detail included: gypsy moth, spruce budworm, hemlock looper, oak leafroller, larch casebearer, eastern tent caterpillar, fall webworm, variable oak leaf caterpillar, yellowheaded spruce sawfly, larch sawfly, spruce beetle, cedar leafminers, serpentine leafminer and oak leafroller; diseases discussed were: Sirococcus shoot blight, Dutch elm disease, Scleroderris canker, balsam fir tip blight, beech bark disease and Rhabdocline needle cast; and abiotic conditions mentioned were: white birch foliage browning, early season weather and winter drying.

Operational control measures were carried out against the spruce budworm, spruce bud moths, seedling debarking weevil, and Dutch elm disease. Experimental trials were conducted against a number of pests including the spruce budworm, spruce bud moths, and Sirococcus shoot blight. Details on pest control are presented elsewhere during the Forest Pest Control Forum. In addition, the spread of the European larch canker is being controlled by the prohibition of transport of larch material from the established quarantine zone.

L.P. Magasi
Forest Insect and Disease Survey
Forestry Canada - Mritimes Region

ISSN 0820-8107

Forestry Canada Forêts Canada

NO. 237

Forestry Canada - Maritimes Region
TECHNICAL NOTE

NURSERIES ☐
PLANTATIONS ☐
SILVICULTURE ☐
UTILIZATION ☐
ECONOMICS ☐
TREE IMPROVEMENT ☐
INSECTS AND DISEASES ☒

HIGHLIGHTS OF FOREST PEST CONDITIONS IN THE MARITIMES IN MID-JUNE 1990

For our clients' information, we will again issue periodic reports on major forest pest conditions in 1990. Our aim is to highlight the more significant problems as they occur and give updates on their development. This report includes information on forest pest conditions, as currently known, in the Maritimes in mid-June 1990.

Corrections to M-X-177 (Forest pest conditions in the Maritimes in 1989). I apologize for the two type-setting errors that resulted in providing incorrect technical information:

page 24, Table 4, Gypsy moth - The two black squares indicating the presence of gypsy moth in Bridgetown, Annapolis County, Nova Scotia, should be under 1988 and 1989 (rather than 1987 and 1988). Thus, gypsy moth was first found in Bridgetown in 1988 and found again in 1989.

page 51, Table 14, New Brunswick plantation survey summary - The total number of plantations examined in Region 5 should read: Total (105), DNR (7), Fras (64), JDI (34), the rest of the line all zeros. The '0' inadvertently placed under Fras caused the shift to the right.

Weather was again a major factor influencing development of both vegetation and forest pests. It was wet, precipitation being well above normal. At some places, precipitation was double or even triple the norm (Buctouche, N.B) for May. In Nova Scotia, precipitation totals for April-May were in excess of 375 mm, which is close to 300 mm more rain than fell last year (that's almost a foot of water!). And it was cool, degree days were lower than normal throughout and much below last year's figures at the end of May. The weather started to "catch up" to normal during the first week of June, but was still lagging much behind 1989's heat accumulation.

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Winter drying of conifers is widespread and, in many areas, severe. Pines, particularly Scots pine, are especially affected. Cold temperatures, coupled with an early January thaw and compounded by many days of strong winds, contributed to the worse than normal foliage discoloration. In some areas, the combination of these factors resulted in buds being killed, the most serious form of winter injury.

Gypsy moth larvae were observed in both New Brunswick and Nova Scotia before the end of May. No other information is available.

Larch casebearer populations are higher than last year throughout the Maritimes, causing considerable foliage loss and discoloration. Overall, the level of discoloration is variable, with severe or moderate discoloration occurring more frequently and affecting larger areas, especially in southeastern New Brunswick.

Scleroderris canker appears to be widespread in pine plantations in the western half of New Brunswick. No assessments are yet available.

Oak leaf roller caused severe or moderate defoliation in scattered pockets in Annapolis, Queens, and Lunenburg counties in Nova Scotia. The full extent of this year's damage is still to be expressed but it appears similar to last year's levels.

Eastern tent caterpillar tents, mostly, but not exclusively, on roadside cherry and apple trees, are more common and more widespread than last year. The most noticeable extension occurred in New Brunswick. Tents are present as far north as the Florenceville-Newcastle line, further north than in previous years. Insect populations also increased in western Nova Scotia.

Rhabdocline needle cast of Douglas fir was found in plantations in all three provinces, causing considerable foliage discoloration.

Other insects and diseases are active but most are in the early stages of development and visible damage to date is minimal.

June 18, 1990

L.P. Magasi
Forest Insect and Disease Survey

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Forestry Canada - Maritimes Region
TECHNICAL NOTE

HIGHLIGHTS OF FOREST PEST CONDITIONS IN THE MARITIMES AT THE END OF JUNE 1990

In this, the second report of 1990, we briefly discuss forest pest conditions as they appeared in the Maritimes at the end of June 1990.

Although a large number of insects and diseases have been active during June, most problems are only of a more or less localized nature. Thus, the lack of major pest problems on a large scale is one of the most noteworthy highlights.

Spruce budworm has largely completed its feeding period and aerial surveys for defoliation are getting under way. It appears that defoliation will be mapped in northern New Brunswick, in patches in eastern Prince Edward Island, and probably in a small part of Cape Breton Island in Nova Scotia.

Hemlock looper larvae are common in collections from New Brunswick and western Prince Edward Island and were also found in Nova Scotia. Larvae, at the end of June, are generally small and, as yet, no noticeable feeding has occurred. In some areas, larvae are numerous, similar in numbers to those present in samples from last year's outbreak in the Christmas Mountain area of Northumberland County, New Brunswick, and high enough to cause concern about expected defoliation.

Gypsy moth larvae were found at several locations in both New Brunswick and Nova Scotia, in areas where the presence of the insect has previously been known. Larvae are not numerous, are small, and no appreciable defoliation has been noted at any of the locations to date. The distribution of pheromone traps to cooperators is well under way and trapping will commence in the second half of July.

NURSERIES ☐

PLANTATIONS ☐

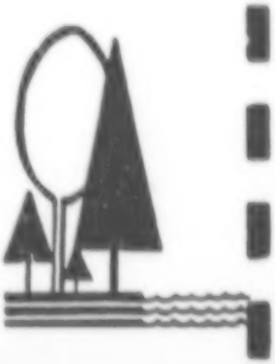
SILVICULTURE ☐

UTILIZATION ☐

ECONOMICS ☐

TREE IMPROVEMENT ☐

INSECTS AND DISEASES ☒



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Cette publication est aussi disponible en français sur demande

Scleroderris canker infections are much more common in New Brunswick than in the past few years. Shoot damage is widespread in red pine and jack pine plantations in western New Brunswick. All lower branches of all trees are infected in some areas. The disease is also present elsewhere. Results of laboratory testing will not be available until late fall, but the fact that all infections have been found on lower branches is encouraging with respect to the North American vs. European race question. Scleroderris canker should be of special consideration during pest assessment surveys in pine plantations.

Serpentine leafminer is again widespread in northern New Brunswick, causing trembling aspen foliage to turn silvery-gray in color. The infestation continues to spread southward. The effects of repeated foliage damage are manifested in twig- and branch-dieback and in generally poor vigor in many northern areas.

Other forest insects and diseases active at the end of June included:

Birch casebearer and birch leafminer caused various degrees of foliage browning in all three provinces; fall cankerworm caused moderate defoliation of elm in Charlottetown, P.E.I; ash rust caused severe and moderate leaf browning along the river near Jordan Falls, Shelburne County, N.S; greenstriped mapleworm adults were caught in some light traps in numbers much higher than in previous years, indicating possible spot outbreaks in all three provinces; polyphemus moth adults are higher than ever before in some light traps; elm leafminer; elm leaf beetle will cause moderate or severe browning in Fredericton; pine leaf adelgid caused shoot mortality on white pine in western Nova Scotia; balsam woolly adelgid; needle cast on Douglas fir in Prince Edward Island and Nova Scotia; spruce beetle; eastern larch beetle; witches' broom of balsam fir; aspen casebearer in Prince Edward Island; white pine blister rust; anthracnose on sugar maple; pear thrips from all three provinces without appreciable foliage damage; a few forest tent caterpillar larvae here and there, the possible start of the next population build-up; uglynest caterpillar creating large unsightly colonies along roadsides in widespread areas, etc.

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TECHNICAL NOTE

☐ NURSERIES

☐ PLANTATIONS

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☐ UTILIZATION

☐ ECONOMICS

☐ TREE IMPROVEMENT

■ INSECTS AND DISEASES

HIGHLIGHTS OF FOREST PEST CONDITIONS IN THE MARITIMES AT THE END OF JULY 1990

In this, the third report of 1990, forest pest conditions as they appeared in the Maritimes at the end of July 1990, are briefly discussed. Although a great number of forest insects and diseases have been active in the Maritimes in 1990, this report is remarkably short on major highlights due to the fact that "the forests, in general, are in pretty good shape."

Spruce budworm aerial surveys have been completed in all three provinces. There is no visible defoliation in Nova Scotia. In Prince Edward Island, moderate or light defoliation occurred in patches of white spruce in the southeastern parts of the province, at levels lower than were observed last year. The New Brunswick information is not yet available.

Spruce beetle has been killing mature and over-mature white spruce trees along uncut valleys and hillsides in many areas of Victoria, Restigouche, and Northumberland counties in northern New Brunswick. Both dead and dying trees are present, indicating that the infestations are not new and are still active.

Sirococcus shoot blight, considered to be mostly a disease of red pine in plantations, caused mortality of current shoots of white spruce in natural stands at several locations in the southern parts of Antigonish and Pictou counties, Nova Scotia. Although damage levels are only trace or light (less than 30% of shoots killed), the fact that the disease is present in natural white spruce stands is significant.

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Stillwell's syndrome, the sudden death of balsam fir trees, appears to be more common than last year throughout New Brunswick and very common in Kings and southeastern Queens counties in Prince Edward Island.

Balsam fir tip blight is common in northern and eastern New Brunswick and has been observed in all three counties in Prince Edward Island. Although infection has been limited to a few scattered semi-mature or mature trees in a given area, shoot damage on affected trees is variable but usually in the light or moderate categories.

Cedar leafminers are causing considerable foliage discoloration at locations in St. John County, New Brunswick, contributing further to their general state of decline. Stands of cedar also suffered moderate and severe damage by leafminers at several locations in Prince County, Prince Edward Island.

Dutch elm disease has not been found outside of its known range, to date, in any of the provinces, but intensification is continuing both in New Brunswick and Nova Scotia with both old and younger trees becoming infected.

Beech bark disease severely damaged two stands in northwestern New Brunswick, in areas where the disease has been least common in the Region until recently. Both the insect (beech scale) and the fungal component (Nectria) are present. Some trees are dead; others are dying.

Other forest insects and diseases active in July included: **alder flea beetle**, very common throughout most of the region at all levels of damage; **elm leafminer**, severe on European variety elm in Queens County, Prince Edward Island and moderate on native elm in central Nova Scotia; **fall webworm** appears to be more common than in previous years, particularly in southwestern Nova Scotia; **elm leaf beetle** has caused moderate and severe leaf browning on many trees in the downtown area of Fredericton, New Brunswick; **birch casebearer**, found causing severe damage to white birch and alder at locations in Kings and Prince counties, Prince Edward Island; **birch leafminer**, common on wire birch throughout southwestern Nova Scotia; etc.

L.P. Magasi and J.E. Hurley
Forest Insect and Disease Survey

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TECHNICAL NOTE

NURSERIES ☐

PLANTATIONS ☐

SILVICULTURE ☐

UTILIZATION ☐

ECONOMICS ☐

TREE IMPROVEMENT ☐

INSECTS AND DISEASES ☑

HIGHLIGHTS OF FOREST PEST CONDITIONS IN THE MARITIMES IN MID-SEPTEMBER, 1990

In this fourth report of 1990, forest pest conditions as they appeared in the Maritimes in mid-September 1990, are briefly discussed.

VARIABLE OAK LEAF CATERPILLAR (*Lochmaeus manteo*), part of a complex of hardwood defoliators, has never been solely responsible as a significant defoliator in the Maritimes in 54 years of survey reports. This year, moderate and severe defoliation of beech was found, with very little defoliation by its often associated complex, at a number of locations in southern York County, New Brunswick and two locations in Queens and Yarmouth counties, Nova Scotia. The most severe damage was at Spednic Lake Provincial Park, York County, New Brunswick, which suffered complete defoliation of approximately 75 hectares of beech.

GYPSY MOTH - Approximately 5500 pheromone traps should soon be collected. As of this date, however, we have very few returns which might indicate catch trends. Egg mass surveys will be conducted by the various cooperating agencies throughout the fall. Please be reminded that prompt return of traps or information on results to FIDS in Fredericton will go a long way towards quickly informing all of our cooperators of the "big picture".

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Cette publication est aussi disponible en français sur demande

Report to the Eighteenth Annual Pest Control Forum

Spruce Budworm Population
Hemlock Looper Population
Herbicide Use
In Nova Scotia, 1990

by

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Deputy Minister
Mr. J. Mullally

Minister
Hon. C.W. MacNeil M.D.

November 1990

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Thomas D. Smith

71 Dr. T.D. Smith

I. INTRODUCTION

The three major surveys of spruce budworm (Choristoneura fumiferana (Clemens, 1865)) in Nova Scotia are: (1) Aerial Defoliation Survey, (2) Moth Flight Survey, and (3) Survey of Overwintering Larvae (L-2 survey). The first two surveys are descriptive in nature and the latter is predictive in nature. In 1985, the L-2 survey superseded the spruce budworm egg-mass survey. The L-2 survey of 1989 noted the end of the decline of infestation in the Province. This year there is an net increase (40 % ; 211 250 ha) of infested gross area in the Province. This is the second year that such a relative increase has occurred (Appendix 1).

II. AERIAL DEFOLIATION SURVEY

The Aerial Defoliation Survey is conducted by the Forest Insect and Disease Survey of Forestry Canada (Truro) with assistance from the Department of Lands and Forest. In summary, no visible defoliation was noted by aerial observers (Magasi 1990 pers. comm.).

III. MOTH FLIGHT SURVEY

The Department in conjunction with Agriculture Canada, Environment Canada, Forestry Canada, Transport Canada, Nova Scotia Department of Education, Nova Scotia Agriculture and Marketing operate a system of light traps to sample photopositive night flying insects. The Department's light traps are carefully monitored during the time of spruce budworm moth flights. This year's weather conditions were favourable for adult migration but no spruce budworm or hemlock looper moth flights were noted from the light trap survey.

IV. L-2 SURVEY

The data from the L-2 survey are used to forecast expected population densities of spruce budworm and define areas of risk from these populations. The spruce budworm larvae migrate after eclosion and before hibernation. For this reason the L-2 data are better estimators of the current population densities than are those data of the egg-mass survey or those from a proposed pheromone trap survey.

A. Methods

1. Field

There were 240 sample locations used for this years survey. Field samples from 219 locations were collected by Departmental personnel and samples from 21 locations were collected by Bowater Mersey personnel. The number of sample points used for this year's survey is a reflection of the past status of the spruce budworm in various parts of the Province (Smith et. al. 1989).

2. Laboratory

The Insectary at Debert has been modified to process L-2 samples. Hibernating spruce budworm larvae are removed from foliage by treating softwood foliage with a hot (66 O°C) solution (1.5 percent volume) of sodium hydroxide. Larvae are separated from plant debris by a differential wetting technique using hexane and are enumerated on gridded filter papers under a Wild-Leitz M5 stereo microscope (Miller et. al. 1971, Miller and Kettela 1982, Dorais and Kettela 1982, and Trial 1984).

In the Maritimes, L-2 data have been traditionally expressed on number of larvae per 45 cm mid-crown balsam fir branch. When dealing with spruce species it is more convenient to sample longer branches (75 - 100 cm) and express these data as number of larvae per 10 square meters as is done in Maine, Quebec, and Newfoundland (Table 1) (Dorais and Kettela, 1982). Sample areas with similar population densities are grouped to produce the L-2 map (Figures 1 and 2).

Table 1. Population assessment and infestation levels of second instar spruce budworm larvae.

Regions	Population Assessment Larvae/branch	 Larvae/10 m^2	Infestation Level
Maritimes	1- 6	--	Low
	7-20	--	Medium
	21-40	--	High
	41- +	--	Extreme
Ontario	1-25	--	Low
	26-65	--	Medium
	66- +	--	High
	--	0	None
Maine	--	1-100	Low
Quebec	--	101-300	Medium
Newfoundland	--	301-650	High
	--	651- +	Extreme

(None = Z; Low = L; Medium = M; High = H; and Extreme = E)
(Dorais and Kettela 1982)

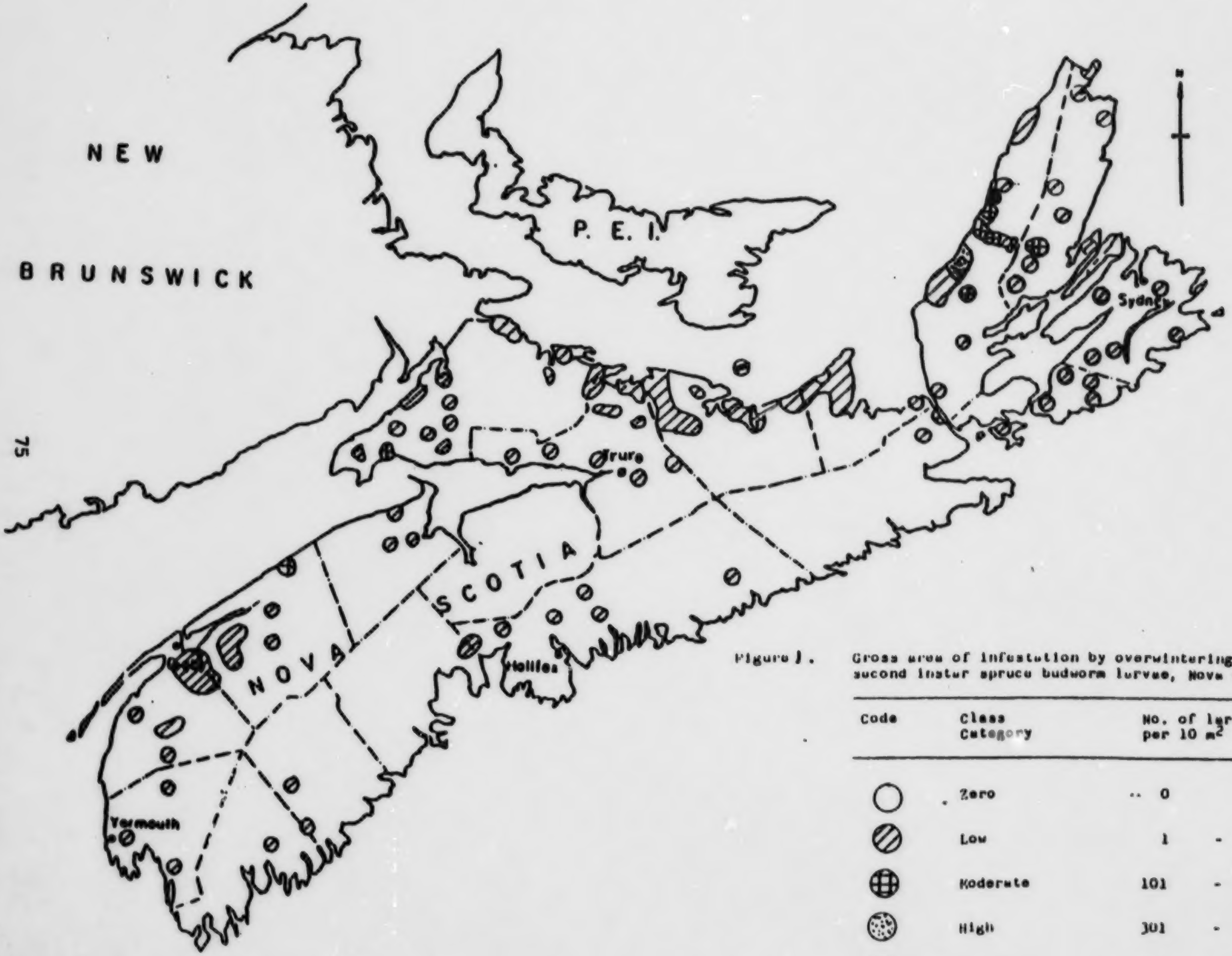
NEW
BRUNSWICK
P. E. I.
N
Sydney
Truro
NOVA SCOTIA
Halifax
Yarmouth

Figure 1. Gross area of infestation by overwintering (1989-1990) second instar spruce budworm larvae, Nova Scotia, 1989.

Code	Class Category	No. of larvae per 10 m^2
○	Zero	0
▨	Low	1 - 100
⊞	Moderate	101 - 300
░	High	301 - 650
●	Extreme	651 +

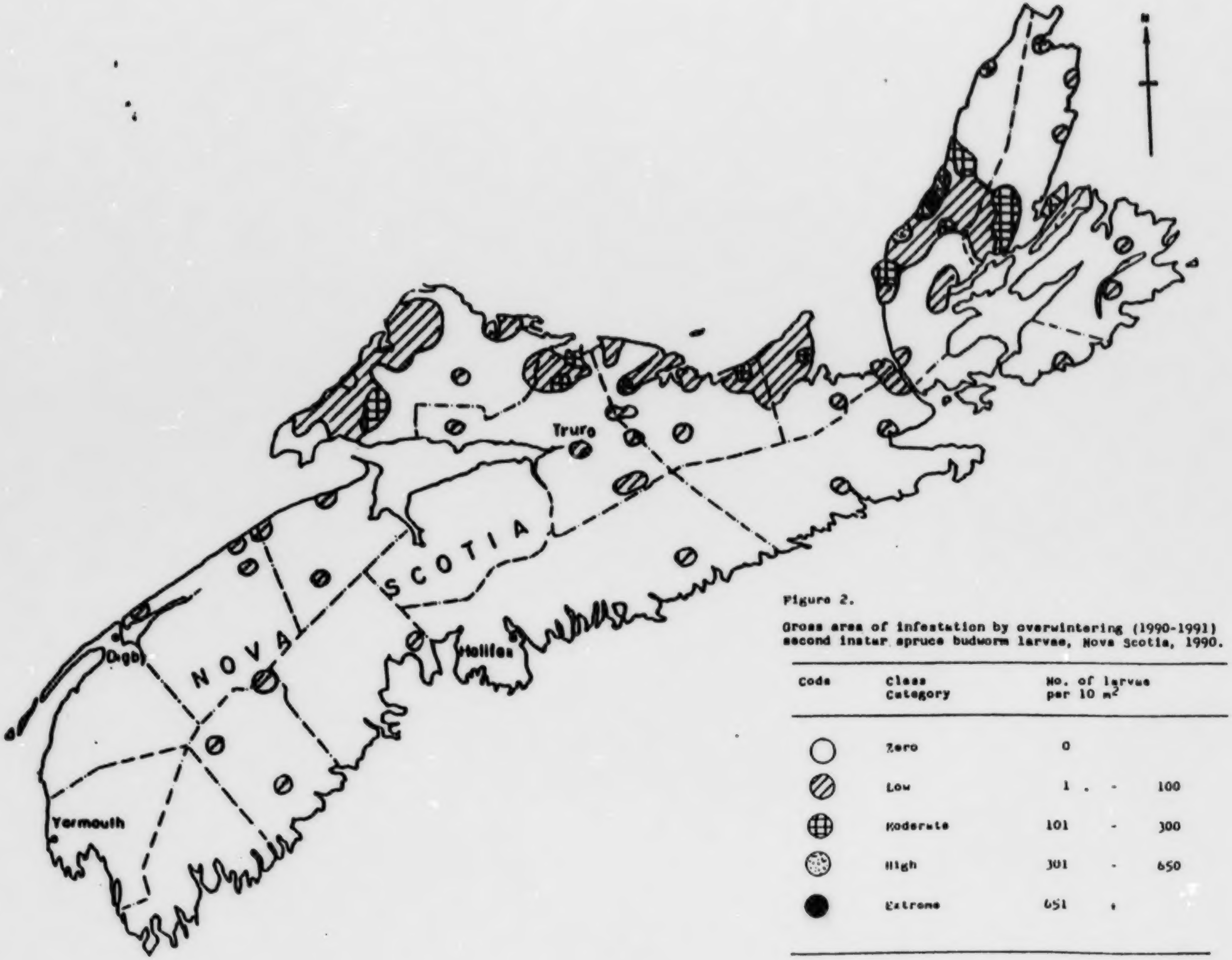
N
Truro
NOVA SCOTIA
Halifax
Digby
Yarmouth

Figure 2.

Gross area of infestation by overwintering (1990-1991) second instar spruce budworm larvae, Nova Scotia, 1990.

Code	Class Category	No. of larvae per 10 m^2
○	Zero	0
▨	Low	1 - 100
⊞	Moderate	101 - 300
◌	High	301 - 650
●	Extreme	651 +

B. Results

1. Microspordia

Monitoring of the gut parasite of spruce budworm Nosema fumiferanae (Thomas) will be done at a later date.

2. Frequency of occurrences of infestation classes

For 1990 the proportion of the number of samples in the zero (52.5 %) and low (35.0 %) changed slightly from those of 1989, 45.2 percent and 49.2 percent respectively; whereas, those of moderate (10.8%) and high (1.3%) doubled from those of 1989; and, those of extreme (0.4%) remained unchanged from that of 1989, (Appendix 2). On Cape Breton Island the frequency of infestation classes in the moderate class increased on the Highlands but decreased on the lowlands (Table 2). The high and extreme populations are persisting along the western coastal area of Inverness County (Table 2). On the northern Mainland there was a slight decrease in the number of locations with no and low populations, but this was offset by a threefold increase in the number of sample areas, from two in 1989 to seven in 1990, having moderate populations (Table 3).

3. Gross area of infestation

a. Cape Breton Island

There is an increase to 250 500 ha (67.3 %) of the gross area infested on Cape Breton Island and these increases occurred in Inverness and Victoria while decreases occurred in Cape Breton and Richmond Counties (Table 4). There were significant increases in areas of moderate populations in Inverness (51 250 ha) and in

Table 2. Frequency of the number of occurrences of L-2 class categories for Cape Breton, Inverness, Richmond and Victoria Counties, Nova Scotia, from 1987 to 1990.

Frequency of the number of Occurrences

Cape Breton

Class Category	1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%
Zero	13	100.0	5	71.4	2	28.6	5	71.4
Low	0	0.0	2	28.6	5	71.4	2	28.6
Moderate	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	13	100.0	7	100.0	7	100.0	7	100.0

Frequency of the number of Occurrences

Inverness

Class Category	1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%
Zero	17	58.6	8	57.1	2	8.7	3	10.7
Low	12	41.4	6	42.9	13	56.5	12	42.9
Moderate	0	0.0	0	0.0	5	21.7	9	32.1
High	0	0.0	0	0.0	2	8.7	3	10.7
Extreme	0	0.0	0	0.0	1	4.3	1	3.6
Total	29	100.0	14	100.0	23	100.0	28	100.0

Frequency of the number of Occurrences

Richmond

Class Category	1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%
Zero	6	100.0	4	80.0	0	0.0	4	80.0
Low	0	0.0	1	20.0	5	100.0	1	20.0
Moderate	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	6	100.0	5	100.0	5	100.0	5	100.0

Table 2. continued

Frequency of the number of Occurrences

Victoria

Class Category	1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%
Zero	15	75.0	8	57.1	5	33.3	7	41.2
Low	5	25.0	6	42.9	8	53.3	4	23.5
Moderate	0	0.0	0	0.0	2	13.3	6	35.3
High	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0
Total	20	100.0	14	100.0	15	100.0	17	100.0

Frequency of the number of Occurrences

Cape Breton Island

Class Category	1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%
Zero	51	75.0	25	62.5	9	18.0	19	33.3
Low	17	25.0	15	37.5	31	62.0	19	33.3
Moderate	0	0.0	0	0.0	7	14.0	15	26.3
High	0	0.0	0	0.0	2	4.0	3	5.3
Extreme	0	0.0	0	0.0	1	2.0	1	1.8
Total	68	100.0	40	100.0	50	100.0	57	100.0

Table 3. Frequency of the number of occurrences of L-2 class categories for Antigonish, Colchester, Cumberland and Pictou Counties, Nova Scotia, from 1985 to 1990.

Frequency of the number of Occurrences

Antigonish

Class Category	1985		1986		1987		1988		1989		1990	
	No	%	No	%	No	%	No	%	No	%	No	%
Zero	2	10.5	6	23.1	12	44.4	10	71.4	3	21.4	1	7.1
Low	7	36.8	12	46.2	13	48.1	3	21.4	11	78.6	12	85.7
Moderate	5	26.3	6	23.1	1	3.7	1	7.1	0	0.0	1	7.1
High	4	21.1	1	3.8	1	3.7	0	0.0	0	0.0	0	0.0
Extreme	1	5.3	1	3.8	0	0.0	0	0.0	0	0.0	0	0.0
Total	19	100.0	26	100.0	27	100.0	14	100.0	14	100.0	14	100.0

Frequency of the number of Occurrences

Colchester

Class Category	1985		1986		1987		1988		1989		1990	
	No	%	No	%	No	%	No	%	No	%	No	%
Zero	7	23.3	10	27.0	18	45.0	14	63.6	6	33.3	8	44.4
Low	10	33.3	16	43.2	17	42.5	8	36.4	12	66.7	8	44.4
Moderate	5	16.7	6	16.2	3	7.5	0	0.0	0	0.0	2	11.1
High	1	3.3	5	13.5	2	5.0	0	0.0	0	0.0	0	0.0
Extreme	7	23.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	30	100.0	37	100.0	40	100.0	22	100.0	18	100.0	18	100.0

Frequency of the number of Occurrences

Cumberland

Class Category	1985		1986		1987		1988		1989		1990	
	No	%	No	%	No	%	No	%	No	%	No	%
Zero	11	14.1	14	13.7	52	51.5	20	41.7	33	63.5	30	60.0
Low	23	29.5	40	39.2	39	38.6	28	58.3	18	34.6	18	36.0
Moderate	18	23.1	28	27.5	6	5.9	0	0.0	1	1.9	2	4.0
High	9	11.5	13	12.7	2	2.0	0	0.0	0	0.0	0	0.0
Extreme	17	21.8	7	6.9	2	2.0	0	0.0	0	0.0	0	0.0
Total	78	100.0	102	100.0	101	100.0	48	100.0	52	100.0	50	100.0

Table 3. continued

Frequency of the number of Occurrences

Pictou

Class Category	1985		1986		1987		1988		1989		1990	
	No	%	No	%	No	%	No	%	No	%	No	%
Zero	3	11.5	12	29.3	27	61.4	15	57.7	10	38.5	11	44.0
Low	4	15.4	13	31.7	11	25.0	11	42.3	15	57.7	12	48.0
Moderate	4	15.4	11	26.8	6	13.6	0	0.0	1	3.8	2	8.0
High	3	11.5	3	7.3	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	12	46.2	2	4.9	0	0.0	0	0.0	0	0.0	0	0.0
Total	26	100.0	41	100.0	44	100.0	26	100.0	26	100.0	25	100.0

Frequency of the number of Occurrences

Northern Mainland Nova Scotia

Class Category	1985		1986		1987		1988		1989		1990	
	No	%	No	%	No	%	No	%	No	%	No	%
Zero	23	15.0	42	20.4	109	51.4	59	53.6	52	47.3	50	46.7
Low	44	28.8	81	39.3	80	37.7	50	45.5	56	50.9	50	46.7
Moderate	32	20.9	51	24.8	16	7.5	1	0.9	2	1.8	7	6.5
High	17	11.1	22	10.7	5	2.4	0	0.0	0	0.0	0	0.0
Extreme	37	24.2	10	4.9	2	0.9	0	0.0	0	0.0	0	0.0
Total	153	100.0	206	100.0	212	100.0	110	100.0	110	100.0	107	100.0

Table 4 . Comparsion of the gross areas of infestation by overwintering spruce budworm larvae for Cape Breton, Inverness, Richmond, and Victoria Counties, Nova Scotia, 1989 and 1990.

County	Gross area (ha) of infestation class category				
	Low	Moderate	High	Extreme	Total
Cape Breton					
1989	19500	0	0	0	19500
1990	15000	0	0	0	15000
Diff.	-4500	0	0	0	-4500
% Diff. (1989)	-23.08	0.00	0.00	0.00	-23.08
Inverness					
1989	43750	18500	10000	3250	75500
1990	96000	51250	10500	3750	161500
Diff.	52250	32750	500	500	86000
% Diff. (1989)	119.43	177.03	5.00	15.38	113.91
Richmond					
1989	18500	0	0	0	18500
1990	6000	0	0	0	6000
Diff.	-12500	0	0	0	-12500
% Diff. (1989)	-67.57	0.00	0.00	0.00	-67.57
Victoria					
1989	28500	7750	0	0	36250
1990	26250	41750	0	0	68000
Diff.	-2250	34000	0	0	31750
% Diff. (1989)	-7.89	438.71	0.00	0.00	87.59
Total					
1989	110250	26250	10000	3250	149750
1990	143250	93000	10500	3750	250500
Diff.	33000	66750	500	500	100750
% Diff. (1989)	29.93	254.29	5.00	15.38	67.28
Total for Moderate+High+Extreme					
1989					39500
1990					107250
Diff.					67750
% Diff. (1989)					171.52

Victoria (41 750 ha) Counties. Only Inverness has insignificant increases of high (500 ha; 5 %) and extreme (500 ha; 15 %), (Table 4, Appendix 1).

b. Mainland

i. Northern

The populations in the Northern Mainland increased (52 %) in all Counties. These increases occurred in areas of low and moderate populations as there were no noted areas of high or extreme (Table 5). Moderate populations (10 750 ha) were noted in Colchester County for the first time since 1987 and in Antigonish County since 1988. There were significant increases in areas of low (127 000 ha) and moderate (12 500 ha) in Cumberland County and significant increases on the area of moderate (11 250 ha) in Pictou County (Table 5).

ii. Southern

With the exception of Guysborough, Kings, and Queens Counties, all Counties in the Southern Mainland had decreases in areas of low population densities. There were no areas noted of moderate, high, or extreme populations in the southern Mainland.

4. Other pests

Care must be taken to monitor possible range overlaps and combined effects of defoliation by the spruce budworm and other spruce-fir defoliators. No significant populations of spruce coneworm (Dioryctria reniculelloides Mut. & Mun.) or spruce budmoth (Zeiraphera canadensis Mut. & Free.) were noted in 1989. The hemlock looper (Lambdina fiscellaria (Guen.)) occupies a similar ecological niche as the spruce budworm. It does, however, utilize

Table 5 . Comparsion of the gross areas of infestation by overwintering spruce budworm larvae for Antigonish, Colchester, Cumberland, and Pictou Counties, Nova Scotia, 1989 and 1990.

County	Gross area (ha) of infestation class category				
	Low	Moderate	High	Extreme	Total
Antigonish					
1989	60750	3000	0	0	63750
1990	69500	4500	0	0	74000
Diff.	8750	1500	0	0	10250
% Diff. (1989)	14.40	50.00	0.00	0.00	16.08
Colchester					
1989	54250	0	0	0	54250
1990	65000	10750	0	0	75750
Diff.	10750	10750	0	0	21500
% Diff. (1989)	19.82	+100	0.00	0.00	39.63
Cumberland					
1989	62500	3250	0	0	65750
1990	127000	12500	0	0	139500
Diff.	64500	9250	0	0	73750
% Diff. (1989)	103.20	284.62	0.00	0.00	112.17
Pictou					
1989	60750	3000	0	0	63750
1990	76000	11250	0	0	87250
Diff.	15250	8250	0	0	23500
% Diff. (1989)	25.10	275.00	0.00	0.00	36.86
Total					
1988	238250	9250	0	0	247500
1989	337500	39000	0	0	376500
Diff.	99250	29750	0	0	129000
% Diff. (1988)	41.66	321.62	0.00	0.00	52.12
Total for Moderate+High+Extreme					
1989					9250
1990					39000
Diff.					29750
% Diff. (1989)					321.62

a greater variety of hosts and feeds from mid-July to mid-August. Tree mortality can occur after one year of severe defoliation. A limited egg-mass survey will be done in the near future.

V. SUMMARY

The area of spruce budworm population in Nova Scotia has increased by 40 percent with significant areas of moderate population densities occurring on the Cape Breton Highlands. Persistent areas of high (10 000 ha) and extreme (3 250 ha) were noted in Inverness County and these areas will require careful monitoring. This year's weather conditions were favourable for adult migrations but no spruce budworm or hemlock looper moth flights were noted from the light trap survey.

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VII. Appendix 1

Gross area of infestation by overwintering second instar spruce budworm larvae, by County, Nova Scotia, 1987-1990.

Gross area (ha) of infestation class category

County	Low				Moderate				High				Extreme				Total			
	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990
A. Cape Breton Island																				
Cape Breton	0	8000	19500	15000	0	0	0	0	0	0	0	0	0	0	0	0	0	8000	19500	15000
Inverness	93500	31250	43750	96000	0	0	10500	51250	0	0	10000	10500	0	0	3250	3750	93500	31250	75500	161500
Richmond	0	4000	18500	6000	0	0	0	0	0	0	0	0	0	0	0	0	0	4000	18500	6000
Victoria	21250	10750	28500	26500	0	0	7750	41750	0	0	0	0	0	0	0	0	21250	10750	36250	68250
B. Mainland i Northern																				
Antigonish	35000	10000	44250	69500	2500	5000	0	4500	2500	0	0	0	0	0	0	0	40000	15000	44250	74000
Colchester	84750	31000	54250	65000	10250	0	0	10750	4750	0	0	0	0	0	0	0	99750	31000	54250	75750
Cumberland	138000	153250	62500	127000	13000	0	3250	12500	6250	0	0	0	6250	0	0	0	163500	153250	65750	139500
Pictou	42000	36750	60750	76000	11250	0	3000	11250	0	0	0	0	0	0	0	0	53250	36750	63750	87250
Mainland ii Southern																				
Annapolis	46500	26750	32000	20500	0	9000	4750	0	0	0	0	0	0	0	0	0	46500	35750	36750	20500
Digby	5750	7750	34750	13000	0	0	0	0	0	0	0	0	0	0	0	0	5750	7750	34750	13000
Guysborough	0	4250	7000	21500	0	0	0	0	0	0	0	0	0	0	0	0	0	4250	7000	21500
Halifax	56250	20750	24750	7500	0	0	0	0	0	0	0	0	0	0	0	0	56250	20750	24750	7500
Hants	5750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5750	0	0	0
Kings	56000	27750	12000	17000	0	0	0	0	0	0	0	0	0	0	0	0	56000	27750	12000	17000
Lunenburg	20250	0	7750	7500	0	0	0	0	0	0	0	0	0	0	0	0	20250	0	7750	7500
Queens	29750	4000	7500	21750	0	0	0	0	0	0	0	0	0	0	0	0	29750	4000	7500	21750
Shelburne	30750	0	4500	0	0	0	0	0	0	0	0	0	0	0	0	0	30750	0	4500	0
Yarmouth	11500	4000	12000	0	0	0	0	0	0	0	0	0	0	0	0	0	11500	4000	12000	0
Total Area (ha)	685000	388250	474250	509750	37000	14000	37250	132000	13500	0	10000	10500	6250	0	3250	3750	741750	402250	524750	736000
% Change from		-296750	86000	115500		-23000	23250	94750		-13500	10000	500		-6250	3250	500		-339500	122500	211250
Previous Year		-43.32	22.15	24.35		-62.16	166.07	254.36		-100	+100	5.00		-100	+100	15.38		-45.77	30.45	40.26

Combination of areas and their respective changes from the previous year

Moderate + High + Extreme				Moderate + High				High + Extreme			
1987	1988	1989	1990	1987	1988	1989	1990	1987	1988	1989	1990
56750	14000	50500	146250	50500	14000	47250	142500	19750	0	13250	14250
	-42750	36500	95750		-36500	33250	95250		-19750	13250	1000
	-75.33	260.71	189.60		-72.28	237.50	201.59		-100	+100	7.55

VIII. Appendix 2

The frequency of the number of occurrences of L-2 class categories by County for Nova Scotia, 1987-1990.

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Frequency of the number of occurrences of L-2 class categories by County, Nova Scotia from 1987 to 1990.

Frequency of the number of Occurrences

Class Category	Annapolis								Antigonish							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	20	69.0	10	62.5	11	61.1	11	61.1	12	44.4	10	71.4	3	21.4	1	7.1
Low	9	31.0	4	25.0	6	33.3	3	16.7	13	48.1	3	21.4	11	78.6	12	85.7
Moderate	0	0.0	2	12.5	1	5.6	4	22.2	1	3.7	1	7.1	0	0.0	1	7.1
High	0	0.0	0	0.0	0	0.0	0	0.0	1	3.7	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	29	100.0	16	100.0	18	100.0	18	100.0	27	100.0	14	100.0	14	100.0	14	100.0

Frequency of the number of Occurrences

Class Category	Cape Breton								Colchester							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	13	100.0	5	71.4	2	28.6	5	71.4	18	45.0	14	63.6	6	33.3	8	44.4
Low	0	0.0	2	28.6	5	71.4	2	28.6	17	42.5	8	36.4	12	66.7	8	44.4
Moderate	0	0.0	0	0.0	0	0.0	0	0.0	3	7.5	0	0.0	0	0.0	2	11.1
High	0	0.0	0	0.0	0	0.0	0	0.0	2	5.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	13	100.0	7	100.0	7	100.0	7	100.0	40	100.0	22	100.0	18	100.0	18	100.0

Frequency of the number of Occurrences

Class Category	Cumberland								Digby							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	52	51.5	20	41.7	33	63.5	30	60.0	18	94.7	5	71.4	2	20.0	8	80.0
Low	39	38.6	28	58.3	18	34.6	18	36.0	1	5.3	2	28.6	8	80.0	2	20.0
Moderate	6	5.9	0	0.0	1	1.9	2	4.0	0	0.0	0	0.0	0	0.0	0	0.0
High	2	2.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	2	2.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	101	100.0	48	100.0	52	100.0	50	100.0	19	100.0	7	100.0	10	100.0	10	100.0

Frequency of the number of Occurrences

Class Category	Guysborough								Halifax							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	10	100.0	6	85.7	5	71.4	3	50.0	6	33.3	6	60.0	4	40.0	9	90.0
Low	0	0.0	1	14.3	2	28.6	3	50.0	12	66.7	4	40.0	6	60.0	1	10.0
Moderate	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	10	100.0	7	100.0	7	100.0	6	100.0	18	100.0	10	100.0	10	100.0	10	100.0

Frequency of the number of Occurrences

Class Category	Hants								Inverness							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	13	92.9	6	100.0	6	100.0	6	100.0	17	58.6	8	57.1	2	8.7	3	10.7
Low	1	7.1	0	0.0	0	0.0	0	0.0	12	41.4	6	42.9	13	56.5	12	42.9
Moderate	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	5	21.7	9	32.1
High	0*	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	2	8.7	3	10.7
Extreme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1	4.3	1	3.6
Total	14	100.0	6	100.0	6	100.0	6	100.0	29	100.0	14	100.0	23	100.0	28	100.0

Frequency of the number of Occurrences

Class Category	Kings								Lunenburg							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	7	41.2	4	40.0	7	70.0	6	66.7	8	66.7	6	100.0	5	83.3	5	83.3
Low	10	58.8	6	60.0	3	30.0	3	33.3	4	33.3	0	0.0	1	16.7	1	16.7
Moderate	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	17	100.0	10	100.0	10	100.0	9	100.0	12	100.0	6	100.0	6	100.0	6	100.0

Frequency of the number of Occurrences

Class Category	Pictou								Queens							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	27	61.4	15	57.7	10	38.5	11	44.0	12	70.6	4	80.0	3	60.0	3	60.0
Low	11	25.0	11	42.3	15	57.7	12	48.0	5	29.4	1	20.0	2	40.0	2	40.0
Moderate	6	13.6	0	0.0	1	3.8	2	8.0	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	44	100.0	26	100.0	26	100.0	25	100.0	17	100.0	5	100.0	5	100.0	5	100.0

Frequency of the number of Occurrences

Class Category	Richmond								Shelburne							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	6	100.0	4	80.0	0	0.0	4	80.0	1	20.0	3	100.0	2	66.7	3	100.0
Low	0	0.0	1	20.0	5	100.0	1	20.0	4	80.0	0	0.0	1	33.3	0	0.0
Moderate	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	6	100.0	5	100.0	5	100.0	5	100.0	5	100.0	3	100.0	3	100.0	3	100.0

Frequency of the number of Occurrences

Class Category	Victoria								Yarmouth							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	15	75.0	8	57.1	5	33.3	7	41.2	7	77.8	3	75.0	3	60.0	3	100.0
Low	5	25.0	6	42.9	8	53.3	4	23.5	2	22.2	1	25.0	2	40.0	0	0.0
Moderate	0	0.0	0	0.0	2	13.3	6	35.3	0	0.0	0	0.0	0	0.0	0	0.0
High	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Extreme	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	20	100.0	14	100.0	15	100.0	17	100.0	9	100.0	4	100.0	5	100.0	3	100.0

Frequency of the number of Occurrences

Class Category	Nova Scotia								Blank							
	1987		1988		1989		1990		1987		1988		1989		1990	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Zero	242	60.5	137	61.2	109	45.4	126	52.5		0.0		0.0		0.0		0.0
Low	137	34.3	84	37.5	118	49.2	84	35.0		0.0		0.0		0.0		0.0
Moderate	17	4.3	3	1.3	10	4.2	26	10.8		0.0		0.0		0.0		0.0
High	2	0.5	0	0.0	2	0.8	3	1.3		0.0		0.0		0.0		0.0
Extreme	2	0.5	0	0.0	1	0.4	1	0.4		0.0		0.0		0.0		0.0
Total	400	100.0	224	100.0	240	100.0	240	100.0	0	0.0	0	0.0	0	0.0	0	0.0

IX. Appendix 3

Population densities of overwintering second instar spruce budworm larvae by County, Nova Scotia, 1990-1991.

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NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Annapolis County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Albany Cross	3394953	18 Sept.	bF	242	65	0.52	0	0	3	0	0	Z
Corey Rd.	3014962	18 Sept.	wS	240	80	0.63	1	0	3	0	0	Z
Crisp Rd.	3354966	18 Sept.	bF	235	98	0.77	0	0	3	0	0	Z
Douglas Rd.	3324981	17 Sept.	wS	215	59	0.42	0	0	3	0	0	Z
East Virginia	3004945	24 Sept.	bF	254	148	1.25	1	0	3	0	0	Z
E. Arlington	3254977	17 Sept.	wS	200	102	0.67	0	0	3	0	0	Z
Halfway Rd.	3494942	18 Sept.	wS	222	73	0.54	0	0	3	0	0	Z
Hampton	3164973	17 Sept.	bF	234	86	0.67	0	0	3	0	0	Z
Hollow Mtn. Rd.	2924957	18 Sept.	wS	225	100	0.75	0	0	3	5	67	L
Lac La Rose	3034953	18 Sept.	wS	236	57	0.45	0	0	3	0	0	Z
Long Lake	3234944	25 Sept.	bF	250	100	0.84	0	0	0	0	0	Z
Maitland Bridge	3214926	24 Sept.	bF	278	192	1.77	0	1	3	0	0	Z
Nictaux	3394975	17 Sept.	wS	210	61	0.42	0	0	3	2	47	L
Round Lake	3434926	25 Sept.	bF	271	170	1.56	0	0	3	1	6	L
Torbrook	3504975	25 Sept.	bF	230	133	1.02	0	0	3	0	0	Z
Victory	3024937	24 Sept.	bF	317	200	2.15	0	0	3	0	0	Z
West Dalhousie	3244958	25 Sept.	bF	277	185	1.72	0	1	2	0	0	Z
Youngs Mtn. Rd.	3074965	18 Sept.	wS	215	77	0.55	1	0	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location Antigonish County	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Arisaig	5645066	10 Sept.	wS	230	133	1.03	1	1	3	8	78	L
Beaver Meadow	5695044	11 Sept.	wS	235	144	1.13	1	0	3	5	44	L
Black Avon	5945044	11 Sept.	wS	240	124	0.99	1	0	3	1	10	L
Cape George	5815078	10 Sept.	wS	235	116	0.91	1	0	3	7	77	L
Dunmaglass	5625061	10 Sept.	wS	235	125	0.98	0	0	3	4	41	L
Dunmore	5835042	11 Sept.	wS	225	111	0.83	0	0	3	0	0	Z
Georgeville	5775074	10 Sept.	wS	230	128	0.99	1	0	3	5	51	L
Greendale	5745069	10 Sept.	wS	235	140	1.09	0	0	3	2	18	L
Havre Boucher	6165058	11 Sept.	wS	230	124	0.95	0	1	3	9	95	L
Lakevale	5825068	10 Sept.	wS	235	133	1.04	0	1	3	14	134	M
Lanark	5825056	11 Sept.	wS	230	118	0.90	0	0	3	3	33	L
Maple Ridge	5675061	10 Sept.	wS	235	153	1.20	1	1	3	11	92	L
Maryvale	5735065	10 Sept.	wS	240	152	1.22	0	0	3	9	74	L
North Grant	5755056	10 Sept.	wS	238	157	1.24	0	1	3	2	16	L

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Cape Breton County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Ben Eoin	6985094	12 Sept.	bF	247	151	1.25	1	2	3	0	0	Z
Big Ridge	7135088	13 Sept.	bF	229	110	0.82	0	2	3	2	24	L
Frenchvale	7025109	12 Sept.	bF	224	138	1.03	0	2	3	0	0	Z
Louisbourg	7355091	12 Sept.	bF	229	135	1.03	0	2	3	0	0	Z
Morrison Rd.	7245106	12 Sept.	wS	208	154	1.05	1	1	3	10	95	L
North Glen	6925078	12 Sept.	bF	228	143	1.08	0	1	3	0	0	Z
Silvermine	7015081	12 Sept.	bF	270	158	1.43	0	1	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location Colchester County	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Balfron	4845058	26 Sept.	rS	236	135	1.03	0	0	3	7	68	L
Barrachois	4785063	26 Sept.	wS	188	145	0.91	1	1	2	20	220	M
Bayhead	4685065	26 Sept.	wS	213	135	0.96	1	1	3	1	10	L
Belmont	4725029	24 Sept.	bF	208	152	1.06	0	0	3	0	0	Z
Denmark	4875060	26 Sept.	wS	229	125	0.96	1	0	3	0	0	Z
Earltown	4875050	26 Sept.	wS	224	108	0.81	0	0	3	0	0	Z
East Earltown	4905057	26 Sept.	wS	173	162	0.94	1	1	2	0	0	Z
Irwin Lk.	4725016	24 Sept.	rS	244	121	0.98	0	0	3	0	0	Z
Lansburg	5055028	26 Sept.	bF	237	157	1.23	0	0	3	2	16	L
Lornevale	4505035	24 Sept.	rS	182	117	0.71	0	0	3	0	0	Z
New Annan	4765053	26 Sept.	rS	220	107	0.78	0	0	3	11	140	M
Newton Mills	5075009	26 Sept.	wS	206	152	1.01	0	0	3	5	49	L
Nuttby	4825044	26 Sept.	rS	229	142	1.09	0	0	3	0	0	Z
Stewiacke	4754997	24 Sept.	bF	256	122	1.04	0	0	3	0	0	Z
Tatamagouche	4745058	26 Sept.	wS	207	95	0.66	1	0	3	3	45	L
Up.Stewiacke	4985006	26 Sept.	wS	208	135	0.92	0	0	3	3	33	L
Valley	4855025	26 Sept.	rS	211	133	0.94	0	0	3	2	21	L
Warwick Mtn.	4695051	26 Sept.	wS	197	125	0.82	0	0	3	3	37	L

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location Cumberland County (East)	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Beecham Sett.	4235089	08 Sept.	wS	216	98	0.70	0	0	3	0	0	Z
Chapman Sett.	4285085	08 Sept.	wS	225	140	1.05	0	0	3	0	0	Z
Cleveland Brk.	4205045	09 Sept.	rS	225	117	0.88	0	0	3	0	0	Z
Conns Mills	4445069	07 Sept.	wS	225	80	0.60	0	0	3	0	0	Z
E. Southampton	4085050	09 Sept.	rS	225	121	0.91	0	0	3	0	0	Z
Fort Lawrence	4055082	08 Sept.	rS	225	122	0.92	0	1	3	1	11	L
Gulf Shore	4545078	07 Sept.	wS	225	124	0.93	1	0	3	3	32	L
Lake Killarney	4315078	08 Sept.	rS	225	140	1.05	0	0	3	0	0	Z
Little Forks	4095063	08 Sept.	rS	220	104	0.76	0	0	3	0	0	Z
MacLellans Brk.	4135081	08 Sept.	rS	225	112	0.84	0	0	3	1	12	L
Mahoneys Corner	4535060	06 Sept.	bS	215	100	0.72	0	1	3	0	0	Z
Malagash	4695069	06 Sept.	wS	230	120	0.93	0	1	3	0	0	Z
Malagash Pt.	4785071	06 Sept.	wS	225	110	0.83	1	0	3	0	0	Z
Middleboro	4545068	07 Sept.	rS	230	97	0.74	0	0	3	0	0	Z
North Wallace	4655075	07 Sept.	rS	221	135	0.99	0	0	3	0	0	Z
Oxford Juncton	4325059	06 Sept.	rS	231	110	0.84	0	0	3	1	12	L
Pugwash	4465077	07 Sept.	wS	223	194	1.45	1	1	3	3	21	L
Ripley Loop	4305073	08 Sept.	rS	223	108	0.81	0	0	3	0	0	Z
Roslin	4395066	08 Sept.	rS	220	87	0.64	0	0	3	0	0	Z
Salt Springs	4215057	09 Sept.	rS	225	123	0.92	1	0	3	0	0	Z
South Athol	4045053	09 Sept.	rS	227	117	0.88	0	0	3	0	0	Z
West Leicester	4125071	08 Sept.	rS	224	103	0.77	0	0	3	1	13	L
Westchester Stn.	4445052	06 Sept.	rS	222	115	0.85	0	1	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location Cumberland County (West)	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Allen Hill	3655027	04 Sept.	bF	200	119	0.80	1	1	3	0	0	Z
Beaver Brook	4225030	24 Sept.	bF	222	97	0.72	1	1	3	0	0	Z
CMU Camp	3945050	17 Sept.	wS	201	158	1.04	1	1	3	17	164	M
Eatonville	3545028	04 Sept.	bF	218	140	1.01	0	1	3	0	0	Z
Five Isl.Park	4185027	24 Sept.	wS	232	99	0.77	1	1	3	0	0	Z
Fowler Brook	3625032	04 Sept.	rS	211	111	0.77	1	1	3	1	13	L
Harrison Rd.	4015066	14 Sept.	rS	226	113	0.85	1	1	3	3	35	L
Harrison Sett.	3925040	07 Sept.	rS	209	138	0.96	1	1	3	13	135	M
Henning Brook	3665034	04 Sept.	bF	226	120	0.91	0	1	3	0	0	Z
Lakelands	3935037	07 Sept.	rS	243	120	0.98	0	1	3	4	41	L
Lynn Mtn.	4135035	24 Sept.	bF	236	105	0.83	1	1	3	0	0	Z
Minudie	3965071	12 Sept.	bS	224	101	0.76	1	1	3	2	26	L
Murphy Brk.	4305039	25 Sept.	rS	214	156	1.09	1	1	3	1	9	L
New Prospect	4015030	24 Sept.	rS	236	126	0.99	1	1	3	0	0	Z
Newton Lk.Rd.	4295031	24 Sept.	bF	213	122	0.86	1	1	3	0	0	Z
North Greville	3785031	04 Sept.	rS	199	79	0.52	0	1	3	1	19	L
Ragged Reef	3855058	12 Sept.	rS	222	117	0.87	1	1	3	3	35	L
Rams Head	3835031	04 Sept.	rS	230	66	0.51	0	1	3	1	20	L
Sand River	3665039	04 Sept.	rS	243	127	1.03	1	1	3	1	10	L
Shulie	3785051	12 Sept.	rS	180	114	0.68	1	1	3	3	44	L
Smith Hollow	3935031	04 Sept.	rS	230	94	0.72	0	1	3	0	0	Z
Station Rd.	4025044	14 Sept.	bF	207	100	0.69	1	1	3	0	0	Z
Twelve Mile	3845044	12 Sept.	bS	231	123	0.95	1	1	3	2	21	L
Two Rivers	3835056	12 Sept.	bS	181	133	0.78	1	1	3	0	0	Z
Up.Bass Rvr.	4385032	25 Sept.	rS	203	76	0.51	1	1	3	0	0	Z
Welton Lake	3825038	07 Sept.	rS	229	119	0.92	1	1	3	4	43	L
W.Apple Rvr.	3545034	04 Sept.	bF	218	93	0.67	1	1	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Digby County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Barris Deadwater	2744958	30 Aug.	bF	288	159	1.53	1	1	2	0	0	Z
Lake Joli	2954928	30 Aug.	bF	237	142	1.12	1	1	3	0	0	Z
Langford Bog	2754910	30 Aug.	bF	280	179	1.69	1	1	2	1	6	L
Lansdowne	2884939	04 Sept.	bF	221	133	0.98	0	1	1	0	0	Z
New France	2754910	04 Sept.	bF	225	160	1.21	0	1	2	0	0	Z
North Range	2734930	04 Sept.	bF	232	146	1.13	0	1	1	0	0	Z
Tom Wallace	2894930	30 Aug.	bF	239	197	1.56	1	1	3	1	6	L
Tuskett Falls	2604862	28 Aug.	rS	235	170	1.34	1	1	3	0	0	Z
Wentworth Lake	2744897	28 Aug.	bF	253	149	1.26	1	1	2	0	0	Z
Weymouth Mills	2674924	28 Aug.	bF	247	146	1.22	1	1	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Guysborough County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Boylston	6155031	06 Sept.	bF	225	162	1.22	1	1	3	3	25	L
Country Hbr.	5905018	05 Sept.	bF	225	121	0.91	0	0	3	0	0	Z
Goldenville	5774996	05 Sept.	bF	225	122	0.92	1	0	3	1	11	L
Lincolnville	6135040	05 Sept.	bF	225	137	1.03	1	1	3	0	0	Z
Mulgrave	6255051	05 Sept.	bF	225	154	1.16	1	1	3	7	61	L
Smithfield	5685013	05 Sept.	wS	225	133	1.00	1	0	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Halifax County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Anti Dam Flowage	5384995	04 Sept.	bF	240	173	1.38	0	0	3	0	0	Z
Indian Hill	4124951	03 Sept.	bF	265	183	1.65	0	1	3	0	0	Z
MacLeod Lake	5024988	04 Sept.	bF	255	146	1.24	0	0	3	0	0	Z
Muskrat Lake	4254957	03 Sept.	bF	243	161	1.32	0	0	3	0	0	Z
Oldham	4594973	04 Sept.	bF	238	175	1.39	0	0	3	0	0	Z
Porters Lake	4734956	04 Sept.	bF	240	154	1.23	0	0	3	0	0	Z
River Lake	5194974	04 Sept.	bF	240	155	1.24	1	1	3	1	8	L
Ship Harbour	5114962	04 Sept.	bF	240	140	1.12	0	0	3	0	0	Z
Stillwater Lake	4334950	03 Sept.	bF	239	147	1.17	1	1	3	0	0	Z
Waverley	4544958	04 Sept.	bF	240	187	1.50	0	0	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Hants County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Admiral Rock	4675002	06 Sept.	bF	235	185	1.45	0	0	3	0	0	Z
Cape Tenny	4385012	06 Sept.	bF	240	182	1.46	0	0	3	0	0	Z
Lacy Mill Lake	4344964	06 Sept.	bF	240	147	1.18	0	0	3	0	0	Z
Stanley	4255000	06 Sept.	bF	240	181	1.45	0	0	3	0	0	Z
Up. Falmouth	4014977	06 Sept.	bF	240	148	1.18	0	0	3	0	0	Z
Up. Kennetcook	4495006	06 Sept.	bF	240	159	1.27	0	0	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Inverness County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Belle Cote	6485145	04 Sept.	bS	122	73	0.30	0	1	3	0	0	Z
Belle Cote	6485146	06 Sept.	wS	155	129	0.67	1	0	3	24	356	H
Big Intervale	6595146	05 Sept.	wS	168	113	0.63	1	1	2	10	158	M
Black River	6295110	05 Sept.	wS	177	104	0.61	1	1	3	11	181	M
Boyles Hill	6325116	07 Sept.	bS	162	153	0.83	0	0	3	6	73	L
Chimney Corner	6415138	05 Sept.	wS	174	112	0.65	1	1	3	12	184	M
Creignish Mtn.	6235062	10 sept.	bS	195	162	1.03	1	1	3	2	19	L
Dunvegan	6355129	03 Sept.	wS	161	89	0.48	1	1	2	41	853	E
Emerald	6485132	04 Sept.	wS	176	118	0.69	0	0	0	5	72	L
Frasers Mtn.	6585136	05 Sept.	bF	220	170	1.25	1	1	3	3	24	L
Grand Etang	6505154	05 Sept.	wS	165	121	0.67	2	1	3	18	269	M
Hayes Rvr.	6345107	07 Sept.	wS	198	113	0.75	1	0	3	4	54	L
Inverside	6325121	03 Sept.	wS	186	112	0.69	0	1	3	20	290	M
Little Judique	6195089	10 sept.	bS	186	137	0.86	0	0	3	6	70	L
Mabou Hilands	6235109	10 sept.	wS	198	117	0.77	0	0	2	2	26	L
Margaree Forks	6455132	06 Sept.	bS	187	159	1.00	0	0	3	4	40	L
Matheson Glen	6475113	05 Sept.	wS	208	132	0.92	1	1	3	12	130	M
Melford	6345082	10 sept.	wS	209	155	1.08	0	0	3	10	92	L
N.E. Margaree	6545131	06 Sept.	bS	202	144	0.96	0	0	3	1	10	L
Plateau	6525161	04 Sept.	wS	172	98	0.57	2	2	3	16	283	M
Pleasant Bay	6665187	14 Sept.	wS	183	106	0.64	0	0	3	8	125	M
Port Hastings	6235056	05 Sept.	wS	148	127	0.63	1	1	3	0	0	Z
Port Hood	6155096	07 Sept.	wS	142	158	0.75	0	0	3	9	121	M
Scotch Hill	6455140	04 Sept.	wS	194	146	0.94	0	0	0	5	53	L
Sight Pt.	6235116	05 Sept.	wS	191	126	0.80	1	1	2	25	312	H
Stewartdale	6435095	05 Sept.	wS	176	132	0.78	1	0	3	4	51	L
St.Rose	6415134	03 Sept.	wS	150	126	0.63	1	1	3	20	316	H
Tower Rd.	6625178	14 Sept.	bF	206	133	0.92	0	0	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location Kings County	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Aylesford Lake	3684981	06 Sept.	rS	225	138	1.04	0	0	3	0	0	Z
Bishop Mtn.	3434989	06 Sept.	wS	225	119	0.89	1	0	3	1	11	L
E. Dalhousie	3604951	06 Sept.	wS	225	140	1.05	0	0	3	0	0	Z
Forest Hill	3934989	06 Sept.	wS	225	135	1.01	0	0	3	0	0	Z
Lake Paul	3674970	06 Sept.	rS	225	137	1.03	0	0	0	0	0	Z
Scott's Bay	3925017	06 Sept.	bF	225	130	0.98	1	0	3	8	78	L
South Alton	3794986	06 Sept.	bF	225	134	1.01	0	0	3	0	0	Z
Victoria Hbr.	3534996	06 Sept.	wS	225	101	0.76	0	0	3	0	0	Z
White's Cnr.	3665001	06 Sept.	wS	225	112	0.84	0	0	3	2	24	L

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location Lunenburg County	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
East River	4034938	12 Sept.	rS	235	114	0.89	0	0	3	0	0	Z
Garber Rd.	3714912	12 Sept.	rS	217	134	0.96	0	0	3	0	0	Z
Hemford	3584928	12 Sept.	bF	240	143	1.17	0	0	3	0	0	Z
Lake Darling	3834952	12 Sept.	bF	205	164	1.13	0	0	3	0	0	Z
Windsor Rd.	3994938	12 Sept.	rS	230	110	0.85	0	0	3	0	0	Z
Whitford Lake	4084942	28 Aug.	rS	221	151	1.12	1	0	3	1	9	L

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location Pictou County	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
6 Mile Brook	5055046	11 Sept.	bS	194	116	0.76	0	0	3	0	0	Z
Alma	5185046	12 Sept.	wS	144	114	0.53	0	0	3	0	0	Z
Avondale Stn.	5535055	18 Sept.	wS	185	120	0.73	1	1	3	8	110	M
Benbie Brook	5105040	17 Sept.	wS	210	125	0.87	0	0	3	4	46	L
Black River	5015056	11 Sept.	wS	153	115	0.58	0	0	0	0	0	Z
Cape John	4925070	10 Sept.	wS	170	170	0.93	1	1	3	7	75	L
Dalhousie Mtn.	4995045	18 Sept.	wS	165	80	0.44	0	0	3	0	0	Z
Egerton	5405051	18 Sept.	wS	160	115	0.61	0	0	3	0	0	Z
Elgin	5255032	17 Sept.	wS	190	125	0.80	1	0	3	4	50	L
Granton	5205050	12 Sept.	wS	194	106	0.70	0	0	3	0	0	Z
Gunn Rd.	4975060	10 Sept.	bF	224	158	1.17	0	0	3	2	17	L
Hardwood Hill	5125056	11 Sept.	wS	168	110	0.62	0	0	3	5	80	L
Hedgeville	4985066	10 Sept.	wS	159	130	0.68	1	1	3	3	44	L
Loch Broom	5175054	12 Sept.	wS	150	97	0.49	0	0	3	0	0	Z
Loganville	4965052	18 Sept.	wS	180	175	1.08	0	0	3	0	0	Z
Meadowville	5075058	11 Sept.	bF	188	130	0.81	0	0	3	0	0	Z
Old Woodburn Rd.	5325051	12 Sept.	wS	177	89	0.52	0	0	3	2	38	L
Otter Rd.	5175064	13 Sept.	bS	180	160	0.93	0	0	3	1	11	L
Piedmont	5485050	18 Sept.	wS	180	115	0.71	1	1	3	3	42	L
Ponds	5575059	18 Sept.	wS	170	120	0.68	1	1	3	3	44	L
Porter Rd.	5035051	11 Sept.	wS	172	90	0.52	1	0	3	9	172	M
Protection Rd.	5085064	10 Sept.	bF	119	97	0.38	0	0	3	0	0	Z
Roys Island	5375056	12 Sept.	wS	168	77	0.43	1	0	3	2	47	L
Sutherland Rvr.	5395046	18 Sept.	bF	185	95	0.60	0	0	3	0	0	Z
Up. Mt. Thom	5005038	17 Sept.	bF	225	155	1.17	1	0	3	3	26	L

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Queens County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Bon Mature Lake	3484886	14 Sept.	bF	228	156	1.20	0	0	3	2	17	L
Conway Brk.	3274885	14 Sept.	bF	205	117	0.80	0	0	3	0	0	Z
Masons Rd.	3224901	14 Sept.	bF	221	137	1.02	0	0	3	1	10	L
Ten Mile Lake	3534894	14 Sept.	bF	209	154	1.07	0	0	3	0	0	Z
Wilkins Siding	3404864	06 Sept.	bS	210	138	0.97	0	1	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Richmond County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Barra Head	6725060	28 Sept.	bF	212	101	0.71	0	0	3	0	0	Z
Lochside	6835071	28 Sept.	bF	220	157	1.15	0	0	3	0	0	Z
Lr. St. Esprit	6975061	28 Sept.	bF	221	105	0.77	0	0	3	1	13	L
MacLeods Lake	6935067	28 Sept.	bF	226	116	0.87	0	0	3	0	0	Z
Martinique	6505046	06 Sept.	bF	209	113	0.79	0	0	3	0	0	Z

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Location	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Victoria County				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Big Barren	6675125	05 Sept.	bF	160	140	0.74	2	1	3	16	217	M
Branch Pond	6945180	13 Sept.	bF	225	112	0.84	0	0	3	0	0	Z
Cape North	6895194	14 Sept.	wS	230	104	0.80	1	1	2	14	175	M
Fire Camp	6675138	05 Sept.	bF	260	140	1.19	2	1	3	28	235	M
Gold Brook	6595122	05 Sept.	bF	218	149	1.10	1	1	3	1	9	L
Green Cove	7015181	13 Sept.	bF	225	100	0.75	0	0	3	5	67	L
Highlands	6775157	12 Sept.	bF	230	109	0.84	1	1	3	0	0	Z
Highlands	6685140	11 Sept.	bF	230	110	0.85	0	1	2	0	0	Z
Kellys Mtn.	6915124	11 Sept.	bF	234	113	0.88	2	1	2	16	182	M
Mile 2	6645112	05 Sept.	bF	240	130	1.04	0	1	3	11	106	M
Mile 8	6685120	05 Sept.	bF	201	102	0.69	1	1	2	8	116	M
Shore Rd.	8975155	13 Sept.	wS	240	104	0.83	1	1	2	5	60	L
St. Columba	6665094	05 Sept.	bF	240	134	1.07	1	1	3	0	0	Z
St. Marg. Vil.	6925206	14 Sept.	bF	225	90	0.68	2	2	2	0	0	Z
Timber Lake	6795137	12 Sept.	bF	235	104	0.82	1	1	2	0	0	Z
We. Middle Rvr.	6585106	11 Sept.	bF	235	104	0.82	1	1	2	6	74	L
Wreck Cove	6895159	12 Sept.	bF	225	100	0.75	0	0	0	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location Shelburne County	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Four Mile Brook	3204881	12 Sept.	bF	219	149	1.09	0	0	3	0	0	Z
Up. Clyde Rvr.	3034862	27 Aug.	bF	265	150	1.33	0	1	3	0	0	Z
Upper Ohio	3044872	27 Aug.	bF	244	114	0.92	0	0	3	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

Location Yarmouth County	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
				Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
Kegeshook Lake	2754873	31 Aug.	bF	240	108	0.87	0	0	3	0	0	Z
Kemptville	2724881	31 Aug.	bF	223	148	1.10	0	0	3	0	0	Z
Pubnico	2784844	28 Aug.	wS	255	110	0.96	0	2	2	0	0	Z

NOVA SCOTIA SPRUCE BUDWORM L-2 SUMMARY SHEET 1990.

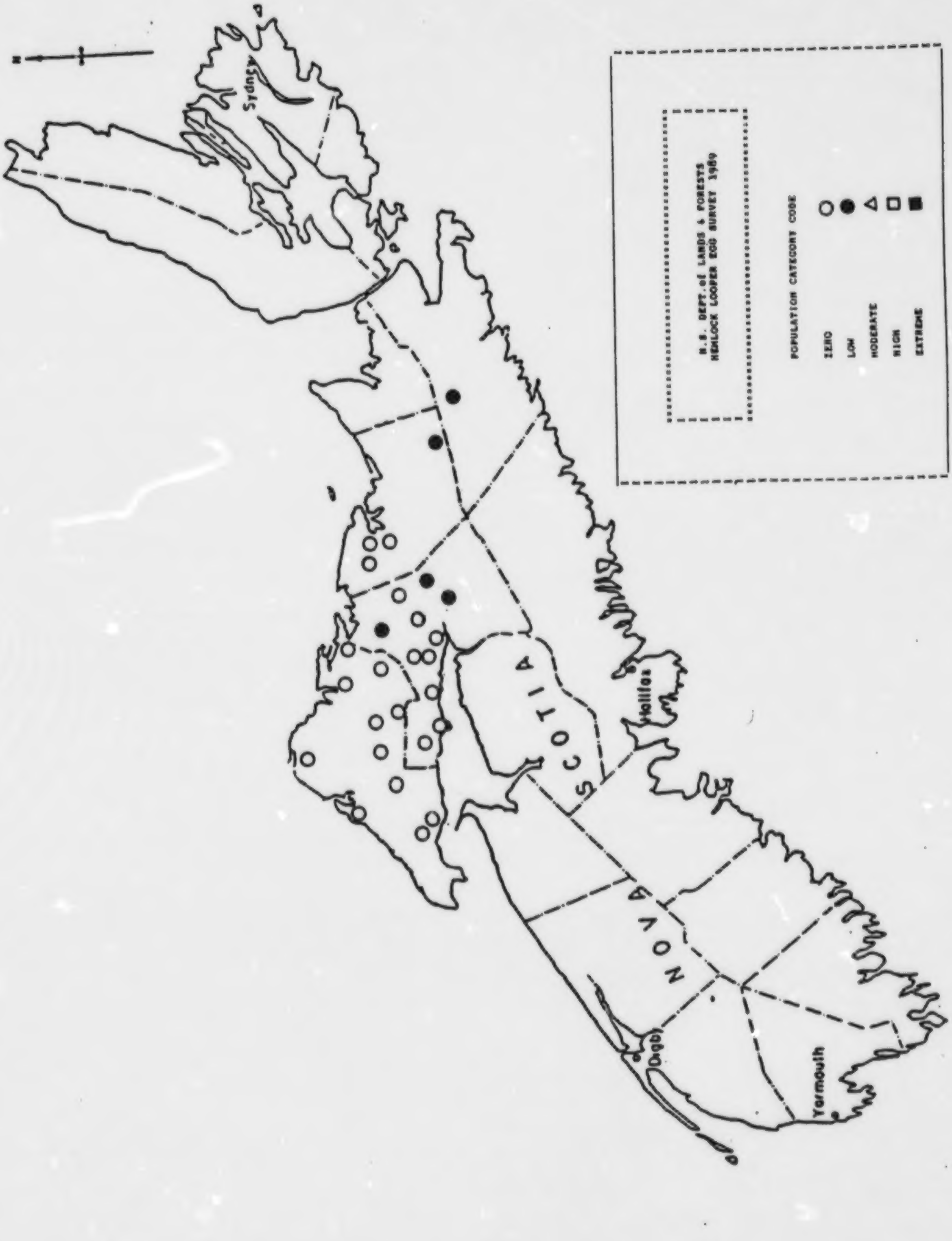
Location	County	UTM GRID Number	Date 1990	Tre Sp.	Branch Size			Defoliation (LAB SUM ONLY)			Population Density		
Bowater Mersey					Len. CM	Wid. CM	Area M^2	Curr	Past	Vig.	Bran	10 m^2	Cat.
East Virginia	Annapolis	3004945	24 Sept.	bF	254	148	1.25	1	0	3	0	0	Z
Long Lake	Annapolis	3234944	25 Sept.	bF	250	100	0.84	0	0	0	0	0	Z
Maitland Bridge	Annapolis	3214926	24 Sept.	bF	278	192	1.77	0	1	3	0	0	Z
Round Lake	Annapolis	3434926	25 Sept.	bF	271	170	1.56	0	0	3	1	6	L
Torbrook	Annapolis	3504975	25 Sept.	bF	230	133	1.02	0	0	3	0	0	Z
Victory	Annapolis	3024937	24 Sept.	bF	317	200	2.15	0	0	3	0	0	Z
West Dalhousie	Annapolis	3244958	25 Sept.	bF	277	185	1.72	0	1	2	0	0	Z
Barris Deadwater	Digby	2744958	30 Aug.	bF	288	159	1.53	1	1	2	0	0	Z
Lake Joli	Digby	2954928	30 Aug.	bF	237	142	1.12	1	1	3	0	0	Z
Langford Bog	Digby	2754910	30 Aug.	bF	280	179	1.69	1	1	2	1	6	L
Tom Wallace	Digby	2894930	30 Aug	bF	239	197	1.56	1	1	3	1	6	L
Tuskett Falls	Digby	2604862	28 Aug.	rS	235	170	1.34	1	1	3	0	0	Z
Wentworth Lake	Digby	2744897	28 Aug.	bF	253	149	1.26	1	1	2	0	0	Z
Weymouth Mills	Digby	2674924	28 Aug.	bF	247	146	1.22	1	1	3	0	0	Z
Whitford Lake	Lunenburg	4084942	28 Aug.	rS	221	151	1.12	1	0	3	1	9	L
Bon Mature Lake	Queens	3484886	14 Sept.	bF	228	156	1.20	0	0	3	2	17	L
Conway Brk.	Queens	3274885	14 Sept.	bF	205	117	0.80	0	0	3	0	0	Z
Masons Rd.	Queens	3224901	14 Sept.	bF	221	137	1.02	0	0	3	1	10	L
Ten Mile Lake	Queens	3534894	14 Sept.	bF	209	154	1.07	0	0	3	0	0	Z
Four Mile Brook	Shelburne	3204881	12 Sept.	bF	219	149	1.09	0	0	3	0	0	Z
Pubnico	Yarmouth	2784844	28 Aug.	wS	255	110	0.96	0	2	2	0	0	Z

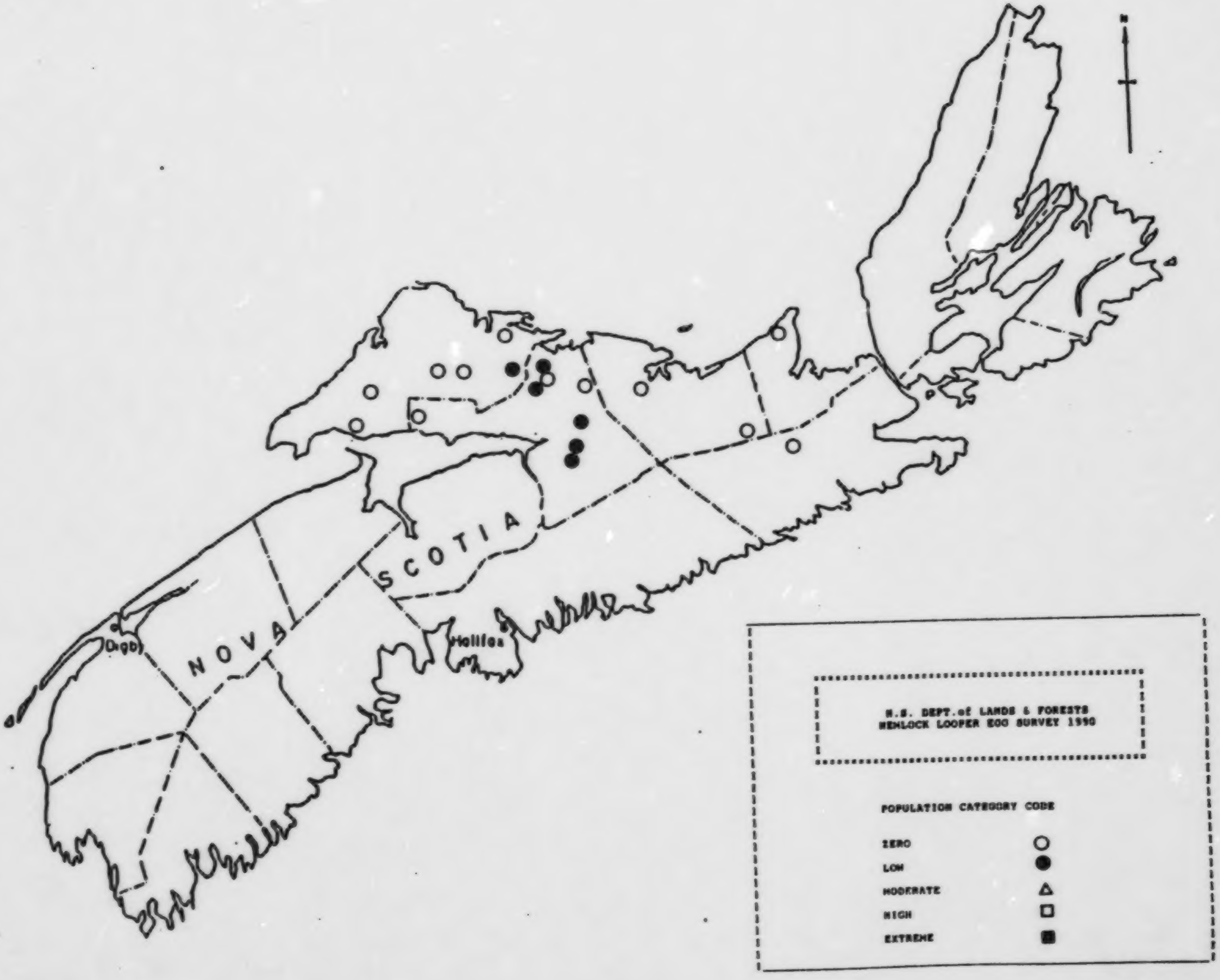
X. APPENDIX 4

Status of hemlock looper

DEPT.of LANDS & FORESTS
HEMLOCK LOOPER SURVEY 1990

County	Location	UTM GRID Number ZONE 020	Population Density								
			No. Eggs/Branch				Percent Eggs				
			Fert	Ster	Para	Sum	Fert	Ster	Para	per 10 m^2	Pop. Cat.
Colchester	Kemptown	4935036	0.5	0	1.7	2.2	22.	0	77.	13	L
Cumberland	Wentworth Center	4585057	0.5	0	0	0.5	100	0	0	11	L
Colchester	Warwick Mtn.	4675053	0.2	0	0.2	0.5	50	0	50	9	L
Colchester	Millbrook	4715056	0.2	0	0	0.2	100	0	0	6	L
Colchester	Camden	4835015	0.2	0	0.7	1	25	0	75	5	L
Colchester	Greenfield	4895024	0.2	0.2	0	0.5	50	50	0	5	L
Cumberland	Wallace River	4585072	0	0	0	0	0	0	0	0	Z
Cumberland	Diligent Rvr.	3865028	0	0	0	0	0	0	0	0	Z
Cumberland	Diligent Rvr.	3855031	0	0	0	0	0	0	0	0	Z
Cumberland	Rvr.Philip Cntre.	4255054	0	0	1.2	1.2	0	0	100	0	Z
Cumberland	Diligent Rvr.	3845032	0	0	0	0	0	0	0	0	Z
Cumberland	Thompson Station	4375057	0	0	0	0	0	0	0	0	Z
Cumberland	Diligent Rvr.	3885029	0	0	0.2	0.2	0	0	100	0	Z
Cumberland	Diligent Rvr."A"	3865028	0	0	0.2	0.2	0	0	100	0	Z
Cumberland	Chignecto Sanct.	3925050	0	0	0	0	0	0	0	0	Z
Cumberland	Diligent Rvr."B"	3865028	0	0	0	0	0	0	0	0	Z
Cumberland	Diligent Rvr.	3875029	0	0	0	0	0	0	0	0	Z
Guysborough	Aspen	5745016	0	0	0.5	0.5	0	0	100	0	Z
Pictou	Georgeville	5755075	0	0	0.2	0.2	0	0	100	0	Z
Pictou	Rocky Mtn.	5615025	0	0	0	0	0	0	0	0	Z
Pictou	Greenhill	5145043	0	0	0	0	0	0	0	0	Z
Colchester	Central Onslow	4715026	0	0	0.2	0.2	0	0	100	0	Z
Colchester	Montrose	4445029	0	0	0	0	0	0	0	0	Z
Colchester	Lynn Mtn.	4135035	0	0	0	0	0	0	0	0	Z
Colchester	Lynn Mtn.	4135038	0	0	0	0	0	0	0	0	Z
Colchester	West New Annan	4715052	0	0	0.2	0.2	0	0	100	0	Z
Colchester	Nuttby	4815044	0	0	0	0	0	0	0	0	Z
Colchester	Nth.Earltown	4895055	0	0	0	0	0	0	0	0	Z


N.S. DEPT. of LANDS & FORESTS
HEMLOCK LOOPER EGG SURVEY 1980
POPULATION CATEGORY CODE
ZERO ○
LOW ●
MODERATE △
HIGH □
EXTREME ■
N
Sydney
Halifax
Digby
Yarmouth
NOVA SCOTIA


N
NOVA SCOTIA
Digby
Halifax
N.S. DEPT.of LANDS & FORESTS
HEMLOCK LOOPER EGG SURVEY 1990
POPULATION CATEGORY CODE
ZERO ○
LOW ●
MODERATE △
HIGH □
EXTREME ■

XI. APPENDIX 5

Herbicide use in 1989 and proposed for 1990

TREATED HECTARES 1989

OWNERSHIP	METHOD	HERBICIDE	TREATED HECTARES
CROWN	AERIAL	VISION	3 659.80
	GROUND	PRINCEP	.00
		VELPAR	.00
		VISION	6.50
*TOTAL OWNERSHIP CROWN			3 666.30
PRIVATE	AERIAL	VISION	6 896.00
	GROUND	PRINCEP	21.70
		VELPAR	118.90
		VISION	662.90
*TOTAL OWNERSHIP PRIVATE			7 699.50
TOTAL			11 365.80

PROPOSED HECTARES 1990

OWNERSHIP	METHOD	HERBICIDE	PROPOSED HECTARES
CROWN	AERIAL	VISION	4 583.00
	GROUND	GAR/VIS	12.00
		GARLON	.38
		VISION	46.00
*TOTAL OWNERSHIP CROWN			4 641.38
PRIVATE	AERIAL	VISION	7 648.90
	GROUND	GARLON	.18
		LON/VIS	.24
		PRONONE	451.90
		SIMIZINE	7.90
		VELPAR	14.60
		VELPAR L	20.00
		VISION	1 993.60
*TOTAL OWNERSHIP PRIVATE			10 137.32
TOTAL			14 778.70

Doc.: 0413J

1990 NEW BRUNSWICK PROTECTION PROGRAM AGAINST SPRUCE BUDWORM

(Prepared* for Annual Forest Pest Control Forum, Ottawa, Nov. 20-22, 1990)

Spruce Budworm Conditions in 1990

The 1990 aerial survey for defoliation caused by spruce budworm revealed 60 000 ha of light, 146 000 ha of moderate, and 91 000 ha of severe defoliation (Figure 1). Approximately 68% of the M-S defoliation was outside the treated areas. Defoliation was detected in largest concentrations throughout the northcentral and northern parts of the Province, primarily in Restigouche, Gloucester and Northumberland Counties. Except for occasional small areas of defoliation, the majority of the rest of the Province was undamaged. The combined area of M-S defoliation (237 000 ha) is 40% less than 1989, and is the lowest it has been since 1967. In fact, only 4 times since 1949 has the area of M-S defoliation been lower.

1990 Spray Program

The 1990 Spruce Budworm Spray Program conducted by Forest Protection Limited, in New Brunswick covered approximately 533 200 hectares (Figure 2). This is 7.6% less than the 576 900 ha treated in 1989. Another 28 600 ha were sprayed by J. D. Irving Ltd. on its own freehold limits (compared to 34 000 ha in 1989).

Various aircraft, equipment, insecticides, and application rates were used (Table 1). Of the total area treated by FPL, 68% received a double application of the chemical fenitrothion (Sumithion). About 22.3% of the area received a double treatment of bacterial insecticide, *Bacillus thuringiensis* var. *kurstaki* (B.t.) in the form of two products, viz. Futura XLV-HP and Biodart (Table 1). A small area (0.4%) received a single application of B.t. The remaining 9.3% received a first application of fenitrothion followed by an application of B.t.

Spray aircraft included 12 TBMs (9 with standard boom and nozzles; 3 with prototype constant-speed electrically-driven rotary atomizers called Sergonairs); and 17 single-engine agricultural-type small spray planes (SSPs) equipped with Micronair AU4000 rotary atomizers. Undiluted B.t. was applied in two applications each at half the normal rate (i.e. 2 x 15 BIU/ha) using SSPs with enhanced atomization (i.e. Micronair AU4000s with flow rates of 2L/min/unit). Fenitrothion was applied in water-based formulation at the normal 210 g/1.46 L/ha rate from TBMs and at 210 g/0.44 L/ha from SSPs with Micronair AU4000s or TBMs equipped with Sergonairs.

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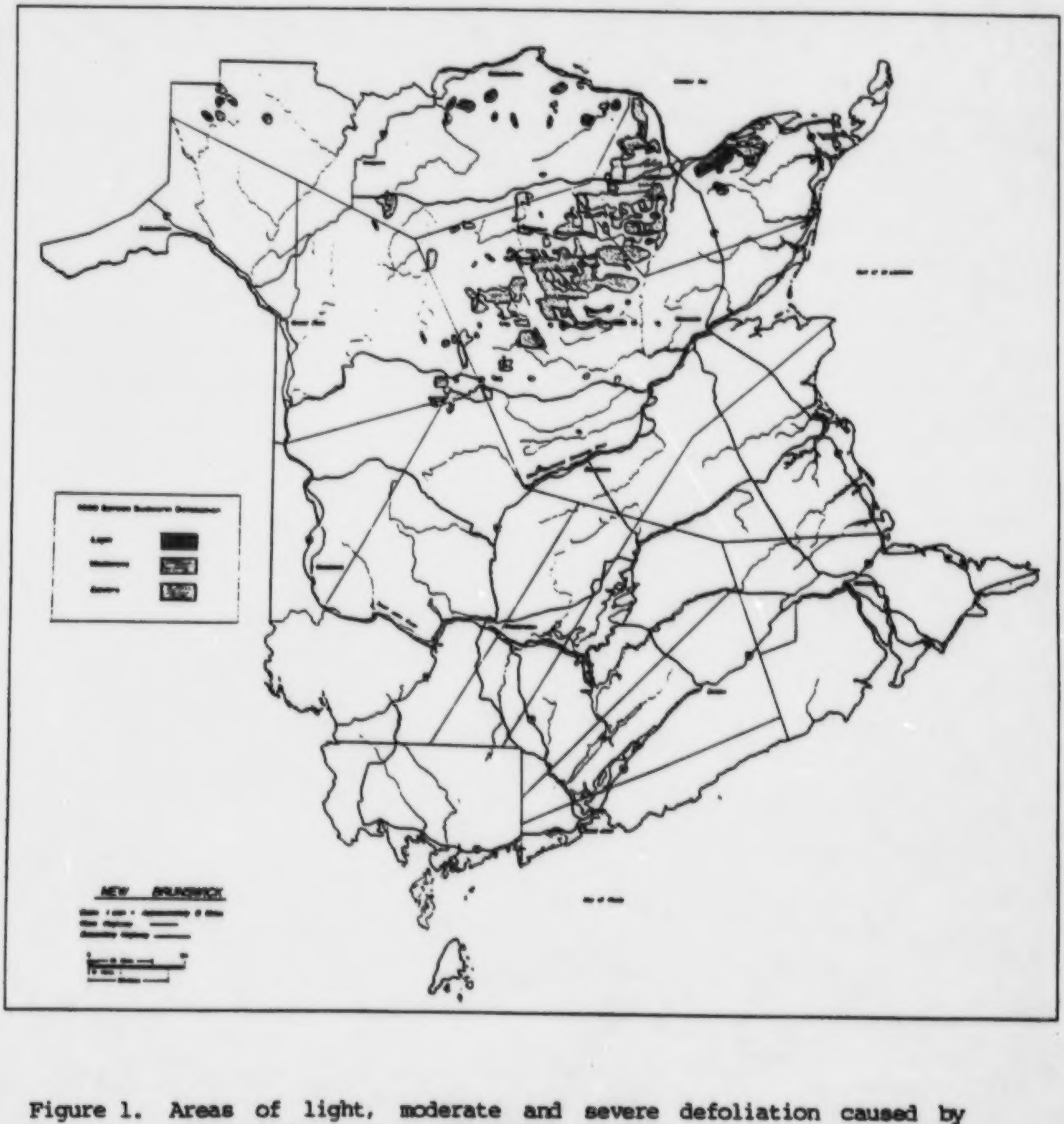
NEW BRUNSWICK

Figure 1. Areas of light, moderate and severe defoliation caused by spruce budworm in New Brunswick in 1990.

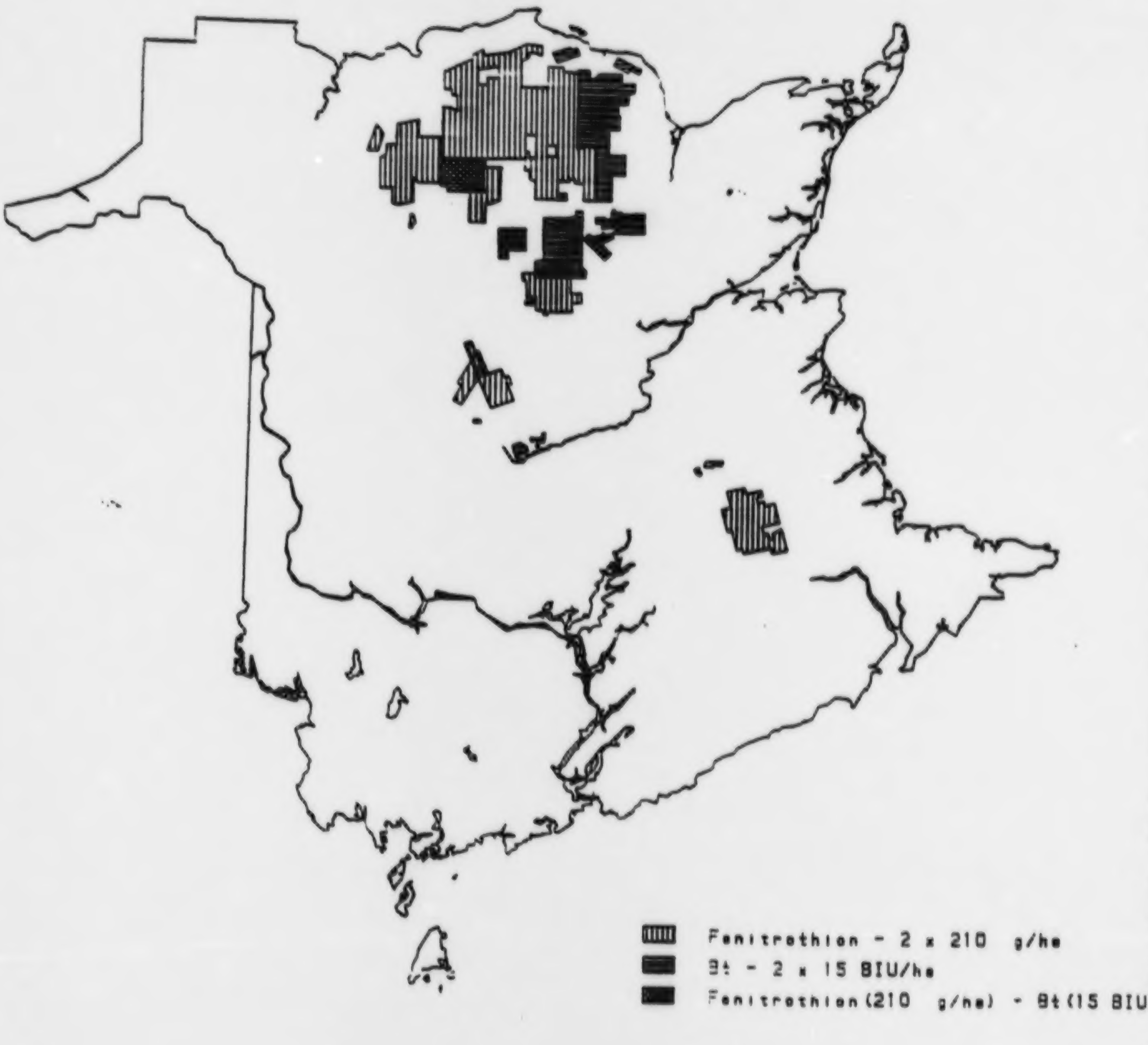
▥ Fenitrothion - 2 x 210 g/ha
■ Bt - 2 x 15 BIU/ha
■ Fenitrothion(210 g/ha) - Bt(15 BIU/

Figure 2. Areas sprayed by FPL for spruce budworm control in New Brunswick in 1990. (Does not include J. D. Irving Ltd. program).

Table 1. Areas sprayed by Forest Protection Limited for spruce budworm control in 1990 in New Brunswick (does not include J. D. Irving Ltd. program).

Treatment[a]	Hectares (Thousands)	Percent	Aircraft Type[b]
One Application - Biological			
30 BIU FXLV-HP/0.90 L/ha	2.0[c]	(0.4)	SSP
Two Applications - Biological			
15 BIU FXLV-HP/0.45 L/ha + 15 BIU FXLV-HP/0.45 L/ha	117.7	(22.1)	SSP
15 BIU BIODART/0.89 L/ha + 15 BIU BIODART/0.89 L/ha	1.2	(0.2)	SSP
SUB-TOTAL:	118.9	(22.3)	
SUB-TOTAL BIOLOGICAL ONLY:	120.9	(22.7)	
Two Applications - Chemical			
210 g Fen/1.46 L/ha + 210 g Fen/1.46 L/ha	194.9	(36.6)	TBM/b
210 g Fen/0.44 L/ha + 210 g Fen/0.44 L/ha	167.7	(31.4)	SSP, TBM/s
SUB-TOTAL CHEMICAL ONLY:	362.6	(68.0)	
One Appl. Chemical + One Appl. Biological			
210 g Fen/0.44 L/ha + 15 BIU FXLV-HP/0.45 L/ha	49.7	(9.3)	SSP, TBM/s
SUB-TOTAL CHEMICAL + BIOLOGICAL:	49.7	(9.3)	
GRAND TOTAL:	533.2	(100.0)	

a. FXLV-HP = Futura XLV HP
BIODART = Biodart
Fen. = Fenitrothion

b. TBM/b = TBM with boom+nozzle
TBM/s = TBM with Sergonair
SSP = Small aircraft with Micronair AU4000

c. Sprayed by FPL on J. D. Irving freehold land.

Cooler than normal temperatures during the latter half of May and early June retarded larval and tree development. As a result the first chemical and B.t. blocks were declared biologically ready for treatment the evening of June 3rd - approximately one week later than last year. By June 12th all blocks were ready for treatment. Poor weather delayed first sprays of chemical and B.t. until June 5th and 6th, respectively. Nevertheless, spray conditions were good for 14 consecutive days during which 99% of the program was completed. All spraying was completed by June 26th (between 3rd and 5th larval instar).

Results of Spray Program

This year, pre-spray populations of spruce budworm larvae were generally greater and the intensity of feeding damage was more severe than in 1989. Once spraying commenced, weather conditions were warm during the spray period, and rain was not a major problem. Shoot elongation and larval development were favorable at the time the blocks were deemed ready for treatment, with shoots slightly ahead of larval development.

Most of this year's efforts were directed at comparing results of the standard 2 x 210 g/ha of fenitrothion against 2 x 15 BIU/ha of B.t., and a combined sequential fenitrothion/B.t. treatment. Comparisons between treatments were restricted to spraying done in blocks within the moderate to high population forecast (Table 2). From the aerial survey, M-S defoliation was detected over 27.4% of the 70 339 ha treated with fenitrothion, 40.0% of the 111 637 ha treated with B.t., and 20.9% of the 48 041 ha treated with fenitrothion/ B.t. The average for spray programs (based mostly on chemicals) for the past 14 years is 17%. Spraying done in other locations was also monitored (Table 3).

Curves of percent defoliation based on pre-spray populations (expressed as larvae/bud) demonstrate that defoliation was generally lower in fenitrothion areas, intermediate in fenitrothion/B.t. areas, and worse in B.t. areas which were still better than untreated areas (Figure 3). Overall, fenitrothion had the lowest mean defoliation (18.6%), highest mean percent reduction in defoliation (72.2%), and highest mean corrected larval mortality (82.2%) compared to either the B.t. (37.8%; 44.3%; 46.2%) or sequential treatment (26.6%; 59.2%; 56.6%).

Forecast of Infestation for 1991

The forecast for 1991 is for 0.99 million ha (Figure 4) of variable (low to high) and moderate to high populations. The area of variable populations has decreased from 0.92 million ha last year to 0.22 million ha this year. Conversely, the area of moderate to high populations has increased from 0.55 million ha in 1989 to 0.77 million ha in 1990. Overall, the forecast for 1991 is 33% lower than the forecast for 1990 (Table 4).

Table 2. Mean larval numbers, larval mortality, and tree defoliation on balsam fir in treated and untreated transects in the M-H forecast area.

		Pre-Spray Larvae		% Mortality		Defoliation		Reduction in Defoliation	
Block	N	/45-cm	/bud	Obs.	Corr.	Exp.%	Obs.%	Abs.*	% **
Bathurst and Newcastle (M-H Forecast):									
Fenitrothion - 2 X 210 g/ha									
A-5	70	6.4	.069	97.6	96.9	39.5	2.2	37.3	93.9
A-10	100	16.0	.184	88.3	76.7	57.3	17.2	40.2	71.6
A-11	25	24.7	.309	78.3	55.6	71.4	41.9	34.1	51.1
A-16	100	12.9	.205	92.8	84.8	56.4	25.6	32.2	62.9
Bacillus thuringiensis - 2 X 15 BIU/ha									
A-4	100	11.8	.109	66.6	45.6	48.9	12.6	36.6	74.0
A-5	100	12.7	.126	70.3	51.7	51.2	21.6	30.5	60.4
A-10	75	19.4	.197	65.8	34.9	60.7	53.0	14.5	25.3
A-11	25	16.6	.132	66.7	38.7	53.7	42.1	16.4	30.9
A-14	100	21.1	.188	77.1	57.3	55.8	44.2	18.5	33.7
A-15	99	25.4	.359	72.9	41.1	73.3	60.6	18.1	26.7
Fenitrothion(210 g/ha) + B.t.(15 BIU/ha)									
A-12	99	7.1	.100	64.7	50.3	44.5	24.4	25.2	59.5
A-13	100	15.4	.186	77.3	59.3	59.9	39.3	23.1	38.0
A-17	100	7.9	.132	76.7	59.9	47.4	16.0	32.8	74.1
Untreated									
C-101	75	26.4	.318	60.9	-	-	83.4	-	-
C-102	50	51.1	.486	68.5	-	-	99.8	-	-
C-103	75	20.7	.236	57.8	-	-	74.5	-	-
C-201	100	3.4	.056	38.1	-	-	21.4	-	-
C-202	100	6.3	.091	56.4	-	-	37.2	-	-

* Absolute reduction in defoliation= Σ (Exp.% - Obs.%)/N

** % Reduction in Defoliation= Σ (((Exp.% - Obs.%)/Exp.%) X 100)/N

Table 3. Mean larval numbers, larval mortality, and tree defoliation in treated and untreated transects in the northern variable forecast area (Campbellton) and blocks in the central and southern portions of the province.

		Pre-Spray Larvae		% Mortality		Defoliation		Reduction in Defoliation	
Block	N	/45-cm	/bud	Obs.	Corr.	Exp.%	Obs.%	Abs.*	% **
Campbellton (Variable Forecast): Fenitrothion - 2 X 210 g/ha									
A-1	50	8.1	.083	95.6	89.8	46.6	8.9	37.8	82.8
A-4	50	4.7	.062	97.7	92.9	35.4	1.6	33.8	90.5
A-5	50	4.6	.059	95.4	85.8	38.2	5.4	32.8	90.0
A-8	40	5.3	.059	98.9	96.6	39.2	9.4	35.7	89.4
Fenitrothion(210 g/ha) + B.t.(15 BIU/ha)									
A-8	50	10.7	.115	81.9	69.8	54.5	14.1	41.0	74.3
Untreated									
C-501	100	1.0	.014	100.0	-	-	1.0	-	-
C-502	50	3.2	.046	67.6	-	-	19.3	-	-
C-503	50	11.7	.114	46.3	-	-	70.0	-	-
C-504	25	12.3	.152	33.9	-	-	77.9	-	-

		Pre-Spray Larvae		% Mortality	% Defoliation
Block	N	/45-cm	/bud	Observed	Observed
Central and Southern New Brunswick: Fenitrothion - 2 X 210 g/ha					
Balsam Fir					
A-19	25	12.2	.135	70.2	31.9
A-20	25	14.5	.147	94.3	23.9
Untreated					
C-419	25	3.8	.048	86.0	9.0
C-420	25	8.8	.097	78.4	22.8
Red/Black Spruce					
A-21	20	19.5	.193	90.7	3.0
A-22	25	3.0	.027	90.2	0.7
Untreated					
C-321	30	12.2	.089	81.0	8.7
C-322	20	9.7	.080	64.1	10.6

* Absolute reduction in defoliation= Σ (Exp.% - Obs.%)/N

** % Reduction in Defoliation= Σ(((Exp.% - Obs.%)/Exp.%) X 100)/N

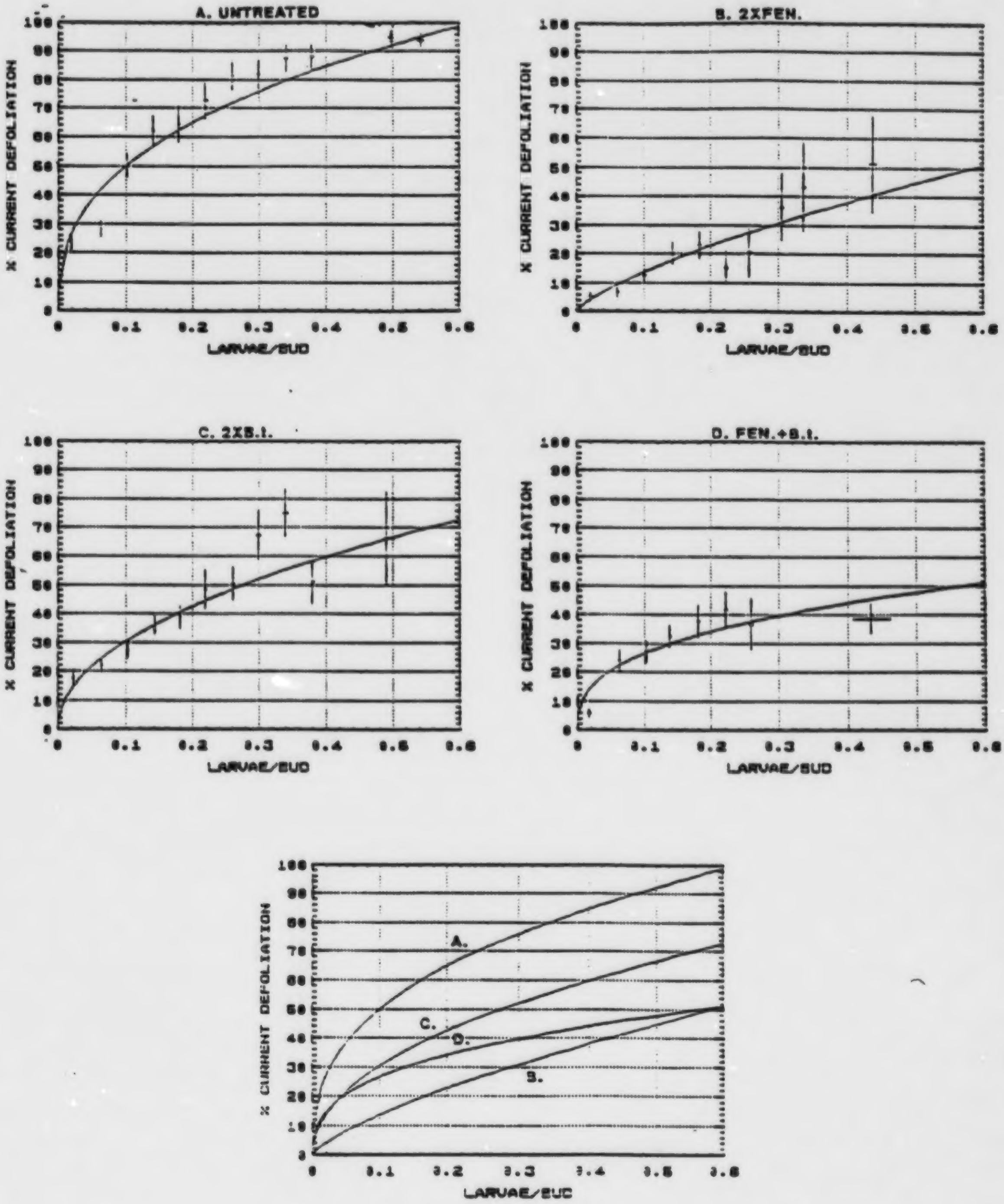

Figure 3. Comparison of relationships between expected defoliation and larvae/bud from treated and untreated check plots in 1990.

Between 1982 and 1986 there was a provincial increasing trend in the percent of forecast points in the Low population category with a corresponding decreasing trend for the High category (Table 5). In 1987, there was a three-fold increase in the proportion of points in the High category in the north-central to northwestern parts of the Province, primarily Restigouche County. Most of Restigouche County contained variable (low to moderate) populations in 1987. Populations have now declined to low throughout most of the County. Moderate to high populations occur in the northwestern part of Northumberland County and adjacent western part of Gloucester County. Except for one area of M-H populations in the west-central area, and one pocket northwest of Moncton no significant damage is expected throughout the majority (85%) of the Province.

Plans for 1991

Spray plans for 1991 area being considered.

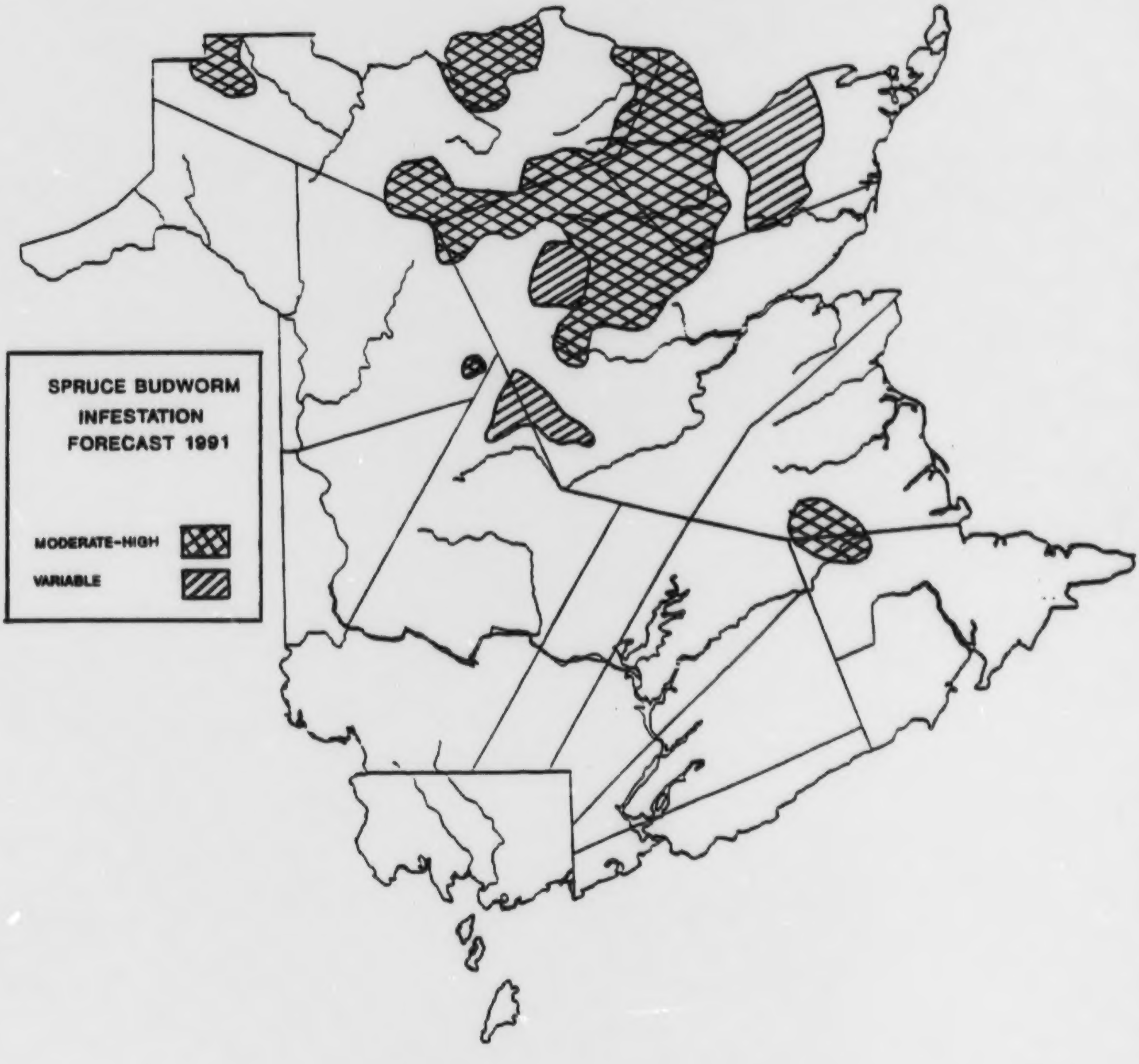
SPRUCE BUDWORM
INFESTATION
FORECAST 1991
MODERATE-HIGH
VARIABLE

Figure 4. Areas of New Brunswick forecast to have variable (low to high), and moderate to high spruce budworm populations in 1991 based on the 1990 L2 survey.

Table 4. Comparison of forecast area (ha) of Moderate and High infestations 1982-1990, including Variable (low-moderate) infestations in 1988 and 1989, and variable (low-high) infestations in 1990.

YEAR (N)	(N + 1) FORECAST
1982	5.30 million ha
1983	4.10 million ha
1984	3.57 million ha
1985	3.15 million ha
1986	1.71 million ha
1987	1.50 million ha
1988	1.65 million ha
1989	1.47 million ha
1990	0.99 million ha

Table 5. Comparison of Spruce Budworm Forecast Infestation Levels 1981-1990.

	FORECAST INFESTATION LEVEL			
YEAR/SURVEY	LOW	MODERATE	HIGH	LOCATIONS[a]
1981/egg-mass	591 (34%)	441 (25%)	708 (41%)	1740
1982/egg-mass	458 (26%)	512 (29%)	783 (45%)	1753
1983/egg-mass	636 (48%)	257 (20%)	423 (32%)	1316
1984/egg-mass	747 (51%)	331 (22%)	398 (27%)	1476
1985/L2	833 (56%)	503 (32%)	185 (12%)	1521
1986/L2	1216 (77%)	322 (20%)	48 (3%)	1586
1987/L2	1198 (76%)	230 (15%)	144 (9%)	1572
1988/L2	879 (73%)	226 (19%)	99 (8%)	1204[b]
1989/L2	1102 (82%)	180 (13%)	67 (5%)	1349[b]
1990/L2	1007 (84%)	128 (11%)	63% (5%)	1198[b]

a - Supplementary sampling not included.
b - Fewer samples taken because of collapse in southern part of province.

Doc.#0001C

1990 HEMLOCK LOOPER SPRAY PROGRAM IN NEW BRUNSWICK

(Prepared for Annual Forest Pest Control Forum, Ottawa, Nov. 20-22, 1990)

1. BACKGROUND

A hemlock looper outbreak* causing severe damage to balsam fir was detected in the summer of 1989 in north-central New Brunswick, in a mountainous area called the Christmas Mountains. This is the first outbreak of hemlock looper ever recorded for New Brunswick. An aerial survey of defoliation was jointly conducted by Provincial and Federal forestry staff who mapped about 3 817 ha of defoliation.

The Department of Natural Resources (DNR) organized a fall egg survey to determine whether populations were great enough to warrant a protection program in 1990. Whereas local data for population and damage forecasting were not available, the system used in Newfoundland was adapted for use. Ninety-three plots were sampled within a 206 000 ha area in northern New Brunswick, surrounding the observed outbreak. In addition, 35 plots were sampled in southern New Brunswick where looper activity was detected during the previous summer. Based on results from the egg survey, an area of 20 000 ha was delineated as containing populations expected to be great enough to cause significant feeding damage in 1990. Subsequently, an area of 21 160 ha in northern New Brunswick encompassing virtually all of the forecast was identified for treatment in 1990.

This report provides results of an operational assessment of spray operations in 1990 which was the first hemlock looper control program ever conducted in New Brunswick. Complementing the operational assessment, Forestry Canada-Maritimes conducted research in one operational spray block treated with B.t. Those results will be reported elsewhere by Forestry Canada.

2. SPRAY PROGRAM

2.1 Spray Plans

The area at risk from looper feeding was divided into three spray blocks (Figure 1). Aerial spray applications were conducted by Forest Protection Ltd. (FPL). The two larger blocks (H & L), which totalled 17 805 ha, received three applications of insecticide as follows: one application of fenitrothion followed by one application of B.t. (Futura XLV) followed by a second application of fenitrothion. Each application of fenitrothion was sprayed at 210 g/1.46 L/ha and the B.t. was applied at 30 BIU/2.03 L/ha. The smallest block (P), 3 355 ha in size, was treated with two applications of B.t. at 30 BIU/2.03 L/ha per application. All applications were made with T.B.M. aircraft, using boom and nozzle spray systems.

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*Brought to DNR's attention by a Forestry Canada-Maritimes official.

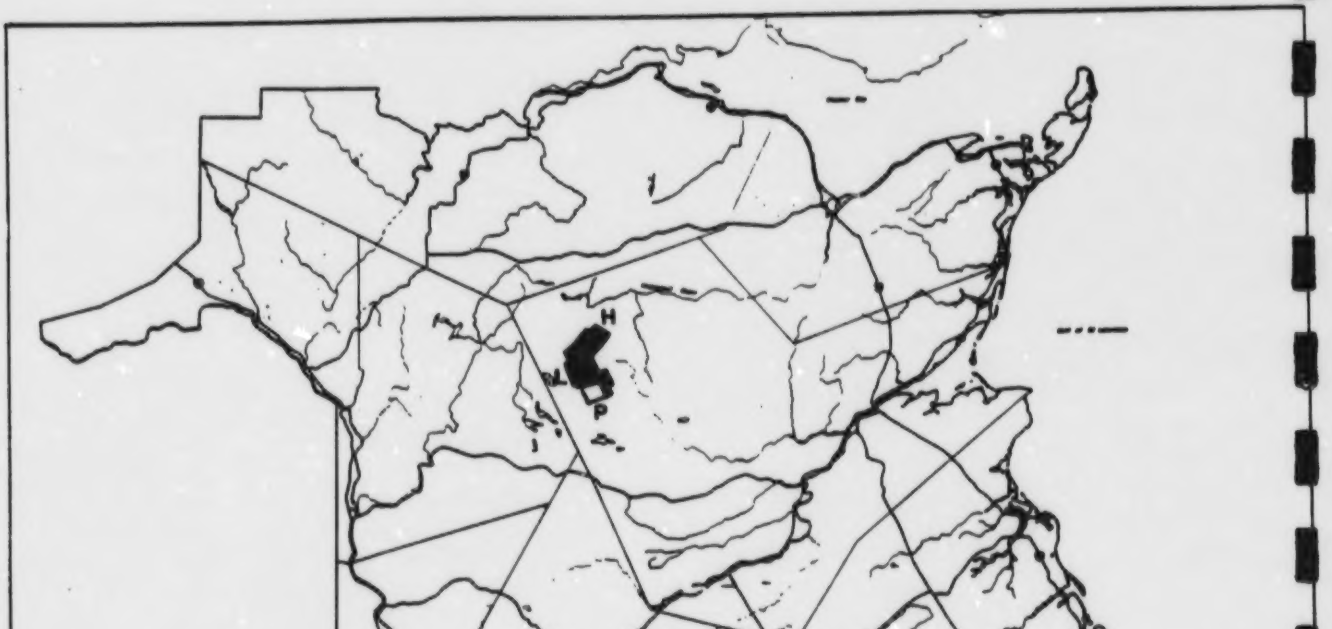
H
L
P
NEW BRUNSWICK 1990 SPRAY PROGRA
FOR HEMLOCK LOOPER
BLOCK H + L - Fenitrothion (210g/ha)
+ B.t. (30 BIU/ha) + Fenitrothi
(210g/ha)
BLOCK P— B.t. at 2x30 BIU/ha

Figure 1. Areas sprayed for hemlock looper control in northern New Brunswick in 1990.

2.2 Spray Timings

DNR staff conducted on-site monitoring of hemlock looper egg hatch and larval development. Both the northern and southern parts of the spray area were monitored. Five plots, of ten trees per plot, were established in each of blocks H and P. One plot of five trees was established in the southern end of Block L which had limited accessibility. Insect development was monitored daily from collections from a subset of plots. Several hundred larvae were examined daily using headcapsule measurements, color, and marking characteristics as criteria to assign each insect to the appropriate instar. Headcapsule widths for each instar were based on work done the previous winter when larvae had been reared from eggs removed from branches collected during the 1989 egg survey. Although sample sizes were limited, these data provided the only available New Brunswick reference material. (Based on work in 1990, there will be a larger data set available for the 1991 field season).

When the blocks were deemed to be biologically ready for each spray application (Table 1), FPL was notified.

Table 1. Biological criteria initially specified for timing spray applications for each spray block.

Treatment	1st Application	2nd Application	3rd Application
Fenitrothion & B.t. & Fenitrothion (Blocks H & L)	90% L1 and 10% L2 with fir shoots flushed.	50% L1 and 50% L2 with fir shoots flushed.	Nominal 5-7 days based on field observations.
B.t. & B.t. (Block P)	90% L1 and 10% L2 with fir shoots flushed.	50% L1 and 50% L2 with fir shoots flushed.	N/A

In the final analysis, these criteria had to be modified to reflect conditions in the field. Due to poor weather for spraying, the first insecticide application was delayed 5-7 days from when blocks were initially deemed to be "biologically ready" (June 20th). This meant that the blocks were ready for second spray applications when larvae were predominently 2nd and 3rd instar rather than 1st and 2nd instar as intended. Spraying commenced on June 25th and was completed by July 6th.

3. ASSESSMENT OF SPRAY PROGRAM

The spray program was assessed in three ways, namely: foliage protection, larval survival, and population change (i.e. egg density). The primary weakness in the assessment is that there were no untreated check areas at similar population levels for comparison. This was because of the decision to include the entire forecast within the spray blocks.

The northern and southern portions of the spray area were monitored for efficacy. Five plots were established in both Block H (the most northern block) and Block P (the most southern block). In total, 100 trees were assessed for egg counts, 95 trees for pre-spray larval counts, and 160 trees for defoliation. Time constraints and limited accessibility did not permit a detailed assessment in Block L, located between the other two blocks, although it was assessed from the air during an aerial survey of defoliation.

The two primary hosts for hemlock looper are balsam fir and hemlock. Spray blocks were comprised primarily of balsam fir and spruce, hence, assessments were restricted to the former.

3.1 Pre-Spray Population - Egg and Larval Counts

Highest looper populations were found in Block H with plot averages from 5-90 eggs per branch compared to 10-29 eggs per branch in plots in Block P. Pre-spray larval counts ranged from 6-50 per branch in Block H, compared to 14-25 per branch in Block P (Table 2).

Table 2. Hemlock looper egg and larval counts prior to insecticide treatment.

		Pre-Spray Populations	
Block I.D.	Plot No.	Eggs/100-cm Branch (n = 10 trees/plot)	Larvae/Branch[1]
H	1	5	6 (10)
	2	11	24 (10)
	3	30	30 (10)
	4	90	35 (5)
	5	86	50 (10)
	Avg.	44	29
P	1	13	21 (10)
	2	12	20 (10)
	3	13	14 (10)
	4	29	25 (10)
	5	10	16 (10)
	Avg.	15	19

---

[1] An attempt was made to cut 45-cm branches, drop them to a tarpaulin, and count all the larvae. Since the larvae fall off the branch when it hits the tarp, all larvae had to be counted, irregardless of deviations in branch length. Cut branches that hit any trees in falling were discarded and another sample taken.

3.2 Foliage Protection

Unlike spruce budworm, which feeds primarily on new or current year's foliage, hemlock looper larvae feed on current year's foliage upon egg hatch and switch to old years' foliage in later instars. This behaviour makes it much more difficult to assess damage caused by this insect in one growing season. To assess foliage protection due to spraying, trees were selected before the growing season and assessed for levels of defoliation on all age classes of foliage. Based on ocular assessments of whole trees (using binoculars) and examining a mid-crown branch, each tree was assigned a defoliation category within 10% classes. After the growing season, following spraying and completion of looper feeding, the same trees were reassessed for defoliation.

In Block H (Fen. + B.t. + Fen.) the condition of trees improved 22% at one plot while two other plots maintained their healthy condition with little foliage loss. However, two other plots experienced a decrease in foliage biomass of 24 and 35% (Table 3). In contrast, the general condition of the monitored trees in Block P (2 x B.t.) improved in all plots, ranging from an increase in total foliage from 25-59% per plot average.

The problem with the assessment, as previously mentioned, is that there were no areas having high looper populations which were left unsprayed. For example, although the trees at two plots in Block H actually deteriorated in terms of foliage retained, we do not know how much worse they could have been without spraying. The change in foliar biomass on the trees from 1989 to 1990 therefore is simply a measure of improvement or decline of the assessed trees and can not be used to determine if one treatment was more efficacious than another, or how beneficial spraying was compared to leaving them untreated.

If only current year's (1990) foliage growth is assessed for damage, mean defoliation at the plot level ranged from 5-41% for Block H (Fen. + B.t. + Fen.) and 21-70% for Block P (2 x B.t.). Note, however, that in the plots at Block P, there was a significant spruce budworm population ranging from 16-38 L3 per branch. Before spraying took place, defoliation attributed to budworm was very noticeable. If defoliation of current year's foliage is corrected to eliminate the amount of budworm feeding, looper defoliation at Block P averaged 4-28% (Table 4). The reader should keep in mind the inherent weakness in a defoliation figure generated in this fashion.

3.3 Larval Survival in Spray Blocks and Certain Untreated Plots

There were several plots in southwestern New Brunswick (Charlotte County) where egg counts were judged to be too low to warrant insecticide treatment. These areas (7 plots of 5 trees/plot), however, were still monitored periodically throughout the summer to assess larval survival and defoliation. Larval survival, in this case, was based on the change in population level from egg hatch (first instar) to predominately third and fourth instar larval development.

Table 3. Comparisons of estimated foliar biomass on trees before and after spraying.

			Percent Foliage Biomass Present on Tree		
Spray Block	Plot No.	No. Trees Sampled	Prior to 1990 Growing Season (a) (avg.)	Following 1990 Growing Season (After Spray Treatment) (b) (avg.)	Percent Increase (or Decrease) in Foliage Biomass $\frac{(b-a)}{a} \times 100\%$
H	1	15	96%	95%	-1%
	2	15	95%	95%	0%
	3	15	79%	60%	-24%
	4	15	78%	51%	-35%
	5	15	64%	78%	22%
P	1	15	66%	92%	39%
	2	15	68%	92%	35%
	3	15	54%	86%	59%
	4	20	51%	74%	45%
	5	20	67%	84%	25%

Table 4. Defoliation on current year's foliage.

Block	Plot No.	No. Trees Sampled	% Defoliation on Current Year's Foliage (a)	% Defoliation Caused By Budworm Feeding[1] (b)	% Defoliation on Current Year's Foliage Corrected For Budworm Feeding (a-b)
H	1	15	5%	0%	5%
	2	15	5%	0%	5%
	3	15	39%	0%	39%
	4	15	41%	0%	41%
	5	15	16%	0%	16%
P	1	15	31%	17%	14%
	2	15	21%	5%	16%
	3	15	44%	40%	4%
	4	20	70%	42%	28%
	5	20	65%	45%	20%

[1] Based on estimated defoliation up to June 24th prior to any spraying against looper and prior to any significant feeding by looper.

Percent survival in spray blocks in northern New Brunswick were significantly lower than the untreated plots in Charlotte County (Figure 2). In Block P (2 x B.t.), 5 1/2 days after final treatment, mean survival was 17% from egg hatch to a larval index of approximately 3.0 (July 5) and Block H (Fen. + B.t. + Fen.), 4-5 days after final treatment, mean survival was 25% from egg hatch to larval index of 3.1 (July 10-11). This compares to 49% survival from egg hatch to larval index of 3.6 - 4.0 (July 12-13) in the untreated plots in Charlotte County. Data were not available from the untreated plots to calculate mean survival for the same period as in the spray blocks; that is, from egg hatch to larval index of 3.0-3.1. Since natural mortality increases over time, it is assumed that the difference in survival between sprayed and untreated plots would be even more significant for an identical larval development period. These data should be interpreted with caution as differences are not necessarily due to insecticide-induced mortality. Hemlock looper outbreaks in several other jurisdictions have been known to rise quickly, and collapse just as quickly. It is, therefore, quite probable that the populations in Charlotte County and in the spray blocks in northern New Brunwick were at different phases in their outbreak cycle and were each behaving in a biologically distinct manner. Hence, density-dependent factors might account for differences observed in survival rates. The Charlotte County untreated population had spring larval counts less than 10 larvae/branch in all but one plot (which averaged 38 per branch). This compares to much higher plot averages of 6-50 larvae/branch in the northern sprayed population.

There was an observed difference in mean survival between the monitored block treated with Fen. + B.t. + Fen. compared to the 2 x B.t. block (Figure 2). The apparent difference in survival between Block H (Fen. + B.t. + Fen.) and Block P (2 x B.t.), was a function of the variable survival rates between plots in Block H. For example, three plots in Block H had low survival, comparable to all five plots in Block P. The remaining two plots had high survival. One possible explanation for the variable rates of survival in the Fen. + B.t. + Fen. block might be uneven spray deposit as plots were located along a transect up the side of a mountain. Conversely, all plots in the B.t. only block were on level terrain, presumably more conducive to "better" spray deposit. (This explanation, however, is only speculative).

The two plots in the Fen. + B.t. + Fen. block (Block H) with high survivorship were the only plots which experienced a net decline in total foliar biomass on the trees (Table 3). These plots also had the most loss of current year's foliage (Table 4).

3.4 Change in Egg Counts Following Spray Applications

Although the primary objective of the spray program was to prevent significant foliage loss which could kill trees in a single year, a secondary objective was to determine if insecticide application could cause enough additional mortality to significantly reduce the number of eggs deposited in the fall of 1990. Reduced egg deposition would thus have an influence on the status of the looper outbreak in 1991.

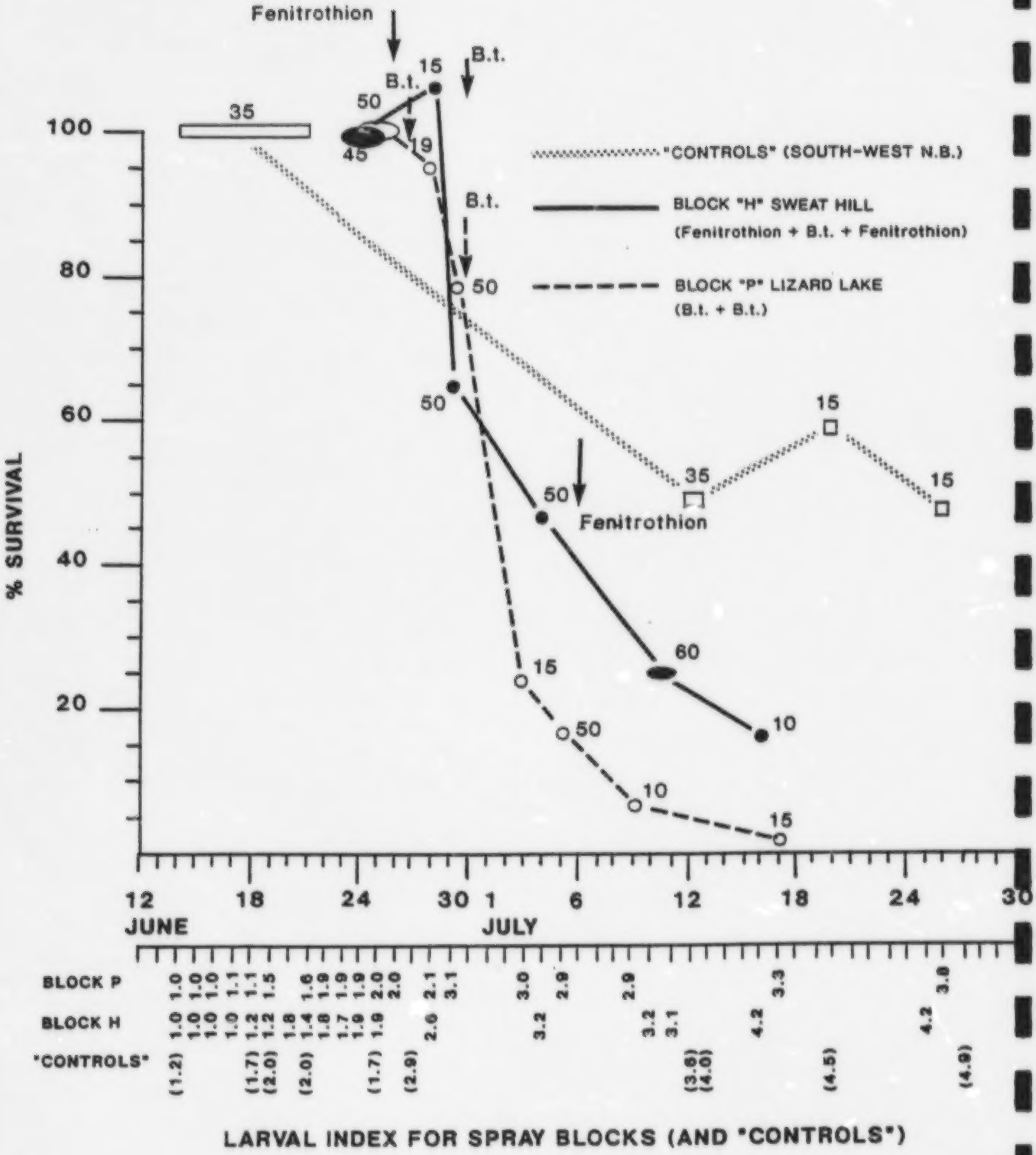

Figure 2. Survival of hemlock looper over time and by larval development index. Time of insecticide applications is illustrated with arrows. The number of trees sampled is on each line.

All plots in the insecticide treated blocks experienced a reduction in egg counts from the fall and winter of 1989/90 to the fall of 1990 (Table 5). The reductions were dramatic, with Block P (2 x B.t.) having a reduction of 91-100% in all monitored plots. Reductions in Block H (Fen. + B.t. + Fen.) ranged from 92-97% in 3 plots to 31-65% in the remaining two plots. In contrast, untreated plots in Charlotte County generally remained unchanged or increased significantly (Table 5). These were the same 7 plots monitored for larval survival, and which had higher larval survival than the sprayed plots. The same observation holds for changes in egg counts as was stated for differences in larval survival - the looper populations in Charlotte County and in the spray blocks in northern New Brunswick may be at different phases in their outbreak cycle, hence density-dependent factors might account for observed differences in egg count population trends. Since there is no adjacent unsprayed area in the same geographical area as the sprayed blocks, it is impossible to determine if the reduction in egg counts following spray applications was due to insecticide-induced mortality or the abrupt natural decline in the outbreak. It is obvious, however, that populations did not increase.

Table 5. Change in Looper Egg Population from the fall and winter of 1989/90 to the fall of 1990.

Block	Plot No.	Egg Count Prior to Spraying (1989/90) (a)	Egg Count After Insecticide Application (b)	Percent Increase (or Decrease) in Egg Count $\frac{b-a}{a}$ x 100%
H (Fen.+ B.t. + Fen.)	1	5.3	0.2	- 96%
	2	10.5	3.7	- 65%
	3	30.4	20.9	- 31%
	4	89.9	7.3	- 92%
	5	85.5	2.6	- 97%
	Avg.	44.3	6.9	- 76%
P (B.t. + B.t.)	1	12.8	1.1	- 91%
	2	11.9	0	- 100%
	3	13.3	0.5	- 96%
	4	29.0	0.8	- 97%
	5	9.5	0.4	- 96%
	Avg.	15.3	0.6	- 96%
Charlotte County (Not Sprayed)	1	7.8	3.0	-62%
	2	1.8	13.2	633%
	3	8.6	10.0	16%
	4	8.2	6.8	-17%
	5	6.4	6.2	-3%
	6	0.4	8.0	1900%
	7	0.6	5.0	733%
	Avg.	4.8	7.4	457%

4. AERIAL ASSESSMENT OF DEFOLIATION CAUSED BY HEMLOCK LOOPER

4.1 Overview (1990)

A specific aerial survey was conducted in late summer (August 15 and 23) for sketch mapping damage. The area of defoliation attributed to hemlock looper during the survey was 3 477 ha, of which 78% included spruce budworm defoliation still visible from the air. Damage was limited to northern New Brunswick in the Christmas Mountains area.

4.2 Efficacy of Spray Program - Overview Based on Aerial Survey

Like the spruce budworm aerial defoliation survey, another aerial survey was done to assess the severity and distribution of the feeding damage by hemlock looper. When sketch maps of defoliation were overlayed on the 1990 spray blocks, it was found that 1 822 ha (9%) of the 21 160 ha sprayed was defoliated by looper, or looper in association with spruce budworm. Broken down by insecticide treatment, 9% of the area treated with Fen. + B.t. + Fen. had detectable defoliation (Blocks H & L); similarly 8% was found in the block treated with 2 x B.t. (Block P).

5. FORECAST FOR 1991

In the fall of 1990, 231 plots were sampled in northern and south-western New Brunswick in zones known to have some looper activity during the summer. At each plot a 100-cm branch was removed from the lower crown of each of 5 trees. Branches were taken to a lab in Fredericton and processed to extract the eggs. The processing procedure, similar to that used in 1989, is a "javex wash technique", based on operational procedures developed by Forestry Canada - Newfoundland.

Based on results of the egg survey, a forecast map will be made to identify areas expected to have significant looper populations in 1991. The Department of Natural Resources will then determine whether a spray program is needed for 1991.

L. Hartling and N. Carter
Forest Pest Management Section
Dept. of Natural Resources & Energy
Fredericton, N.B.

Dec. 12, 1990

FOREST PROTECTION LIMITED

1990 PROGRAM REPORT

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July 16, 1990

FOREST PROTECTION LIMITED

1990 PROGRAM REPORT

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Forest Protection Limited

1990 Program

Areas Treated Operationally

Area Sprayed in Hectares by Insecticide and Aircraft Type

SPRUCE BUDWORM

Insecticide	Dosage	No. Hectares	Aircraft Type
Fenitrothion	2 x 210 g/ha	362 635	TBM (Boom & Nozzle) TBM (Serg/onair) (1 Ag-Cat Ag-Truck Thrush M-18
Fenitrothion + B.t.	1 x 210 g/ha + 1 x 15 BIU/ha	49 695	TBM (Serg/onair) (1 Ag-Cat Thrush M-18
B.t.	2 x 15 BIU/ha or 1 x 30 BIU/ha	120 855	Ag-Cat Ag-Truck Thrush M-18
	TOTAL:	533 185	

HEMLOCK LOOPER

Insecticide	Dosage	No. Hectares	Aircraft Type
Fenitrothion + B.t. + Fenitrothion	1 x 210 g/ha + 1 x 30 BIU/ha + 1 x 210 g/ha	17 805	TBM (Boom & Nozzle)
B.t.	2 x 30 BIU/ha	3 355	TBM (Boom & Nozzle)
	TOTAL:	21 160	

TOTAL AREA SPRAYED: 554 345 Hectares

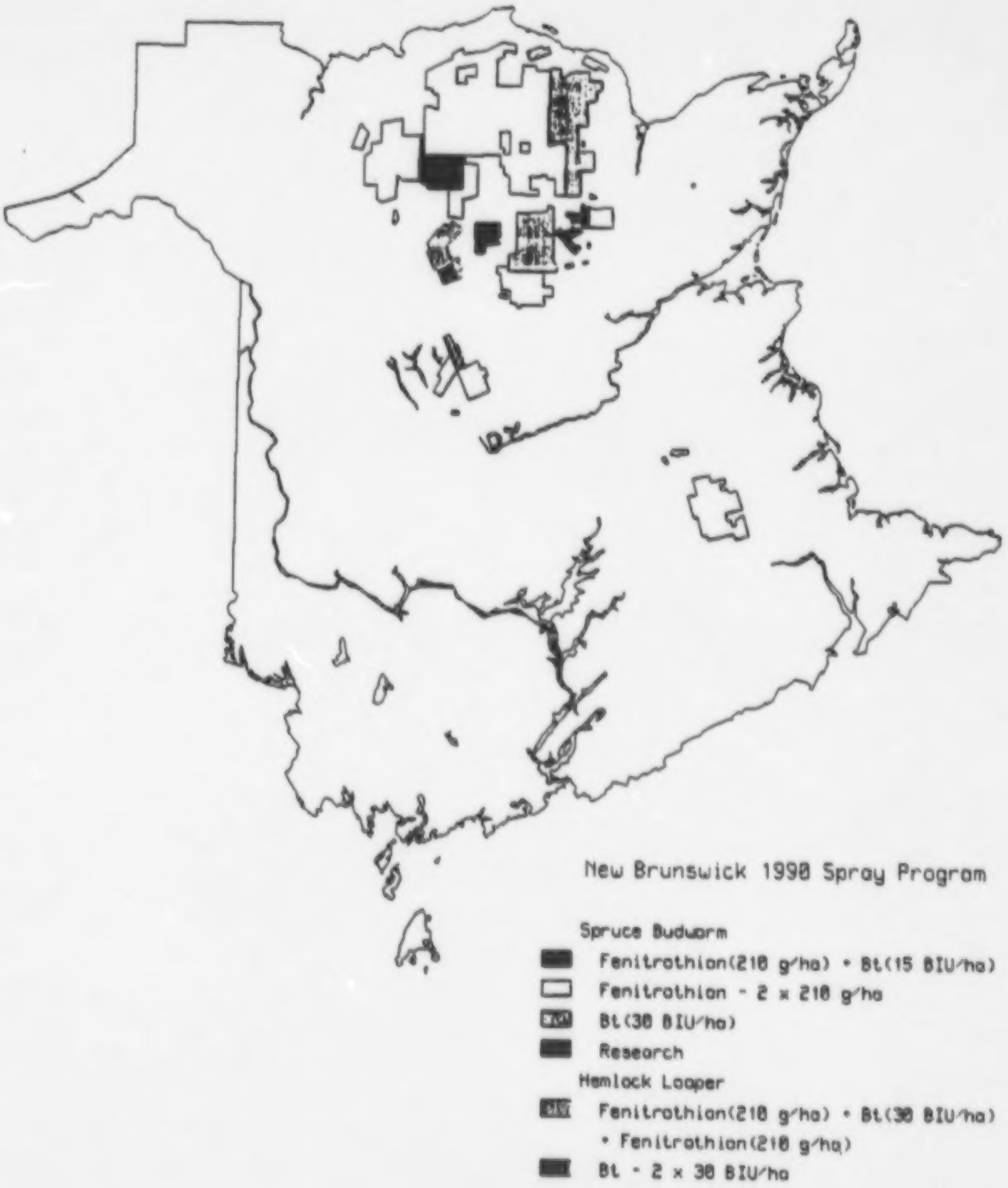
(1) Serg/onair is an electric atomizer currently under development

S.H. Napper
July 9, 1990

1990 SPRAY AREA, BY INSECT, TREATMENT AND OWNERSHIP (HECTARES)

INSECT	TREATMENT	OWNER Department of Natural Resources and Energy	NBIP Forest Products Inc.	J.D. Irving Limited	Total
Spruce Budworm	Fenitrothion	354 755	7 880	---	362 635
	Fenitrothion + B.t.	49 695	---	---	49 695
	B.t.	118 175	680	2 000	120 855
	TOTAL	522 625	8 560	2 000	533 185
Hemlock Looper	Fenitrothion + B.t. + Fenitrothion	17 805	---	---	17 805
	B.t.	3 355	---	---	3 355
	TOTAL	21 160	---	---	21 160

S.H. Napper
July 9, 1990


New Brunswick 1990 Spray Program
Spruce Budworm
Fenitrothion(210 g/ha) + Bt(15 BIU/ha)
Fenitrothion - 2 x 210 g/ha
Bt(30 BIU/ha)
Research
Hemlock Looper
Fenitrothion(210 g/ha) + Bt(30 BIU/ha) + Fenitrothion(210 g/ha)
Bt - 2 x 30 BIU/ha

GENERAL

Authorizations

By letter of February 19, 1990 from the Deputy Minister of Natural Resources and Energy (DNRE), Forest Protection Limited (FPL) was authorized to proceed on behalf of DNRE with the purchase of materials and aerial spraying contracts for the 1990 spray program sufficient for 500 000 ha.

At a meeting of the Board of Directors of FPL on March 16, 1990 it was "proposed that up to a maximum of 550 000 ha be sprayed for spruce budworm control and 20 000 ha be sprayed for hemlock looper control". The insecticides to be used were fenitrothion and B.t. at the ratio of 75:25 chemical:B.t.

At the same meeting "it was Resolved that the General Manager at this time be authorized to make commitments for R&D projects to be conducted in the 1990-91 fiscal year not to exceed $400,000".

By letter of April 30, 1990 from the Deputy Minister of DNRE, FPL was authorized to purchase additional B.t. insecticide for spraying as a middle application between fenitrothion treatments on the hemlock looper blocks.

Permit to Spray

On April 06, 1990 a completed "Application for a Permit (Aerial)" was submitted to the Minister of Environment. An addendum to this application was requested on May 07, 1990 for the use of Futura XLV B.t. on the hemlock looper areas.

By letter dated May 10, 1990, and signed by Hon. Vaughn Blaney, the authorization for aerial application of insecticides was granted as outlined in the April 06 request for permit. The addendum was approved in a letter dated May 22, 1990 and signed by the Minister.

(Copy of permit/addendum in Appendix, pg A-1).

On May 17, 1990 Hon. Morris Green signed a letter of agreement to implement Order-in-Council #90-399, which authorized FPL to carry out the spray program as specified.

(Copy of letter in Appendix, pg A-7).

Support Facilities

Through April and May mixing and loading facilities were set up on the following airstrips:

Bathurst
Budworm City
Charlo
Dunphy
Sevogle

Complete kitchen, dining and sleeping facilities were established at Budworm City, Charlo and Sevogle. The kitchen and dining facilities at Dunphy were operated by DNRE and FPL was charged on a meals taken basis. Arrangements were made for personnel working at Bathurst to live and eat at the most convenient motels and restaurants.

Aircraft Contracts

A fleet of 29 spray aircraft and 29 navigation aircraft was assembled for the project. A helicopter was retained on contract for search and rescue purposes. Details of ownership and type of aircraft used are in the Appendix, pg A-9.

Insecticide Purchased

Purchase orders were issued as follows:

Fenitrothion - to Sumitomo Canada Limited for 761 drums each containing 250 kg of 96% technical fenitrothion, total of 190 250 kg @ $13.86 per kg.

Futura XLV-HP - to Chemagro Limited for 131 500 litres B.t. at 33.0 B.I.U.s per litre, total of 4 339 500 B.I.U.s @ $0.306 per B.I.U.

Futura XLV - to Chemagro Limited for 49 500 litres B.t. at 14.8 B.I.U.s per litre, total of 732 600 B.I.U.s @ $0.306 per B.I.U.

Biodart - to C.I.L. Inc. for 1 800 litres B.t. at 16.9 B.I.U.s per litre, total of 30 420 B.I.U.s at $0.330 per B.I.U.

All B.t. products were fully utilized with no inventory currently remaining. FPL currently has an inventory of 11 166 litres of fenitrothion. Details of insecticide utilization and inventory are in the Appendix, pg A-10.

Block Openings

The first budworm blocks to be treated with fenitrothion and B.t. at normal spray timing were declared biologically ready by DNRE for June 03, but weather did not permit spraying to commence until June 05 with fenitrothion and June 06 with B.t.

Further budworm blocks were declared ready on subsequent days until all blocks were opened by June 12. All first applications were completed by June 13 and the normal spraying with both applications was completed on June 26.

All hemlock looper blocks to be treated were declared biologically ready by DNRE for June 20, but weather did not permit spraying to commence until June 25. All first applications were completed on June 28, all second applications on July 01, and all third and final applications were completed on July 06.

Weather

The spruce budworm larvae developed later than usual this year due to the cold weather conditions experienced in May. This resulted in one of the latest starts in recent years for aerial spraying against the budworm. Once spraying started it continued for fourteen straight days due to "very good" spray weather conditions such that 99% of the budworm areas were completed during this period. It took eight days to complete the remaining 1% due to "very poor" spray weather conditions.

"Normal" spray weather conditions were experienced after starting treatment of the hemlock looper areas. Delays were mainly due to required timings of second and third applications rather than weather conditions.

Accidents and Incidents

There were no accidents or incidents involving aircraft, insecticide jettisoned loads or spills.

Research & Development

Research and development projects undertaken to date in 1990 are related to B.t./fenitrothion efficacy against high larval populations of spruce budworm ($165,000); a comparison of spray deposition efficacy of two spray systems ($62,800); a measurement in the variability in spray deposit in operational spray blocks treated with two spray systems ($20,000); and the development of a B.t. product for control of the hemlock looper ($24,880). Details of each proposal can be found in Appendix, pg A-11.

Information Centre

An Information Centre was operated in the FPL office in Lincoln, as announced by public notice in New Brunswick newspapers. A toll-free service was available from any part of the Province for those requesting information. This service was in operation daily from 5 a.m. to 10 p.m. during the project period. The Information Centre personnel were bilingual. Their duties included answering all calls in a factual manner and arranging for call-backs if the requested information was not readily available.

In addition, information in both English and French as to areas for spraying was sent daily by FAX for distribution via the New Brunswick Information Service closed circuit teletype. This same information was also made available to a toll-free Code-a-Phone service on a 24 hour-a-day basis.

RESULTS OF THE 1990 PROGRAM AND FORECASTS FOR 1991

DNRE is presently carrying out surveys to assess the results of the 1990 spray project. Also, surveys will continue to be carried out as a basis for predicting 1991 populations. Analysis of these surveys will be available this autumn.

D.C. Davies
July 16, 1990

Forest Pest Conditions in
Quebec - 1990

Introduction

THIS REPORT PRESENTS A SUMMARY OF THE GENERAL CONDITION OF SELECTED INSECT AND DISEASE PROBLEMS OF ACTUAL IMPORTANCE IN QUEBEC. DETAILS ON THESE PROBLEMS AS WELL AS ADDITIONAL INFORMATION ON OTHER PESTS OF LESSER IMPORTANCE WILL BE REPORTED IN THE FIDS REGIONAL REPORT "INSECTES ET MALADIES DES ARBRES, QUEBEC 1990" WHICH WILL BE PUBLISHED IN EARLY 1991.

IN QUEBEC REGION, THE GENERAL INSECT AND DISEASE SURVEY IS DONE BY THE "SERVICE DE LA PROTECTION CONTRE LES INSECTES ET LES MALADIES" (SPIM) OF THE QUEBEC MINISTRY OF ENERGY AND RESOURCES. MUCH OF THE INFORMATION PRESENTED HEREIN ORIGINATES FROM A MID-SEASON REPORT PREPARED BY THE SPIM AND ENTITLED: "FAITS SAILLANTS AU 31 JUILLET 1990". FIDS-LFC IS RESPONSIBLE FOR SPECIAL SURVEYS, FOREST PROBLEMS RELATED TO QUARANTINE MONITORING AND CONTROL, AND NATIONAL SURVEY AND MONITORING PROGRAMS.

Spruce budworm (Choristoneura fumiferana (Clem.))

THE AREA INFESTED INCREASED 26% IN 1990 (TO ABOUT 1.26 MILLION HA) COMPARED TO 1989 (0.92 MILLION HA). MOST OF THE DAMAGE WAS CONCENTRATED IN THE GASPE PENINSULA AND ON THE NORTH SHORE OF THE ST. LAWRENCE RIVER. ELSEWHERE IN THE PROVINCE THE INSECT IS AT AN ENDEMIC LEVEL.

IN THE GASPE PENINSULA, DEFOLIATION WAS OBSERVED ON ABOUT 1,1 M HA, AN INCREASE OF APPROXIMATELY 25% OVER 1989. A LARGE PROPORTION OF IT IS IN THE MODERATE TO SEVERE CLASS OF DAMAGE. AERIAL CONTROL SPRAY WAS DONE ONLY IN THIS AREA THIS YEAR, OVER APPROXIMATELY 476,000 HA. B.T. WAS USED EXCLUSIVELY. IN LOWER-ST-LAWRENCE REGION, THE SEVERITY OF DAMAGE DECREASED TO LIGHT DEFOLIATION IN MOST OF THE AREAS THAT SUSTAINED MODERATE TO SEVERE DAMAGE IN 1989. MOST OF THESE AREAS HAD BEEN SPRAYED WITH B.T. LAST YEAR.

ON THE NORTH SHORE, THE INFESTATION IS LOCATED NORTH OF FORESTVILLE. ABOUT 160,000 HA WERE DEFOLIATED, MOST OF IT SEVERELY, AN INCREASE OF 37% OVER THAT OF 1989. THE DEFOLIATION WAS ALSO GENERALLY MORE SEVERE THIS YEAR THAN IN 1989. NO CONTROL SPRAY PROGRAM WAS CARRIED OUT IN THIS REGION.

THE FORECAST FOR 1991 IS A REDUCTION OF 85%, TO ABOUT 200,000 HA, IN THE AREA OF MODERATE TO SEVERE DEFOLIATION IN THE GASPE PENINSULA. ELSEWHERE IN THE PROVINCE, THE SITUATION SHOULD REMAIN UNCHANGED.

Forest Tent Caterpillar (*Malacosoma disstria* Hbn.)

IN WESTERN QUEBEC (ABITIBI-TEMISCAMINGUE REGION), AN INFESTATION CENTER WHICH HAD BEEN SEVERE A FEW YEARS AGO AND WHICH HAD DECLINED TO LIGHT AND MODERATE DEFOLIATION LEVELS OVER ABOUT 800,000 HA IN 1989, JUST ABOUT SUBSIDED IN 1990. ONLY SMALL LOCAL CENTERS REMAIN. A SERIES OF LATE FROSTS IN SPRING 1990, COULD HAS HELPED IN THAT POPULATION DECREASE.

IN TROIS-RIVIERES AND SAGUENAY-LAC-SAINT-JEAN REGIONS, CENTERS THAT HAD SPREAD TO ABOUT 30,000 AND 20,000 HA RESPECTIVELY IN 1989, STILL INCREASED SLIGHTLY IN AREA AND IN SEVERITY OF DEFOLIATION IN 1990. HOWEVER, THE INCREASE WAS SMALLER THAN EXPECTED. AGAIN SEVERE SPRING CLIMATE CONDITIONS WOULD EXPLAIN THIS SITUATION.

ELSEWHERE IN THE PROVINCE, THIS INSECT IS PRESENT BUT CAUSES LITTLE DAMAGE.

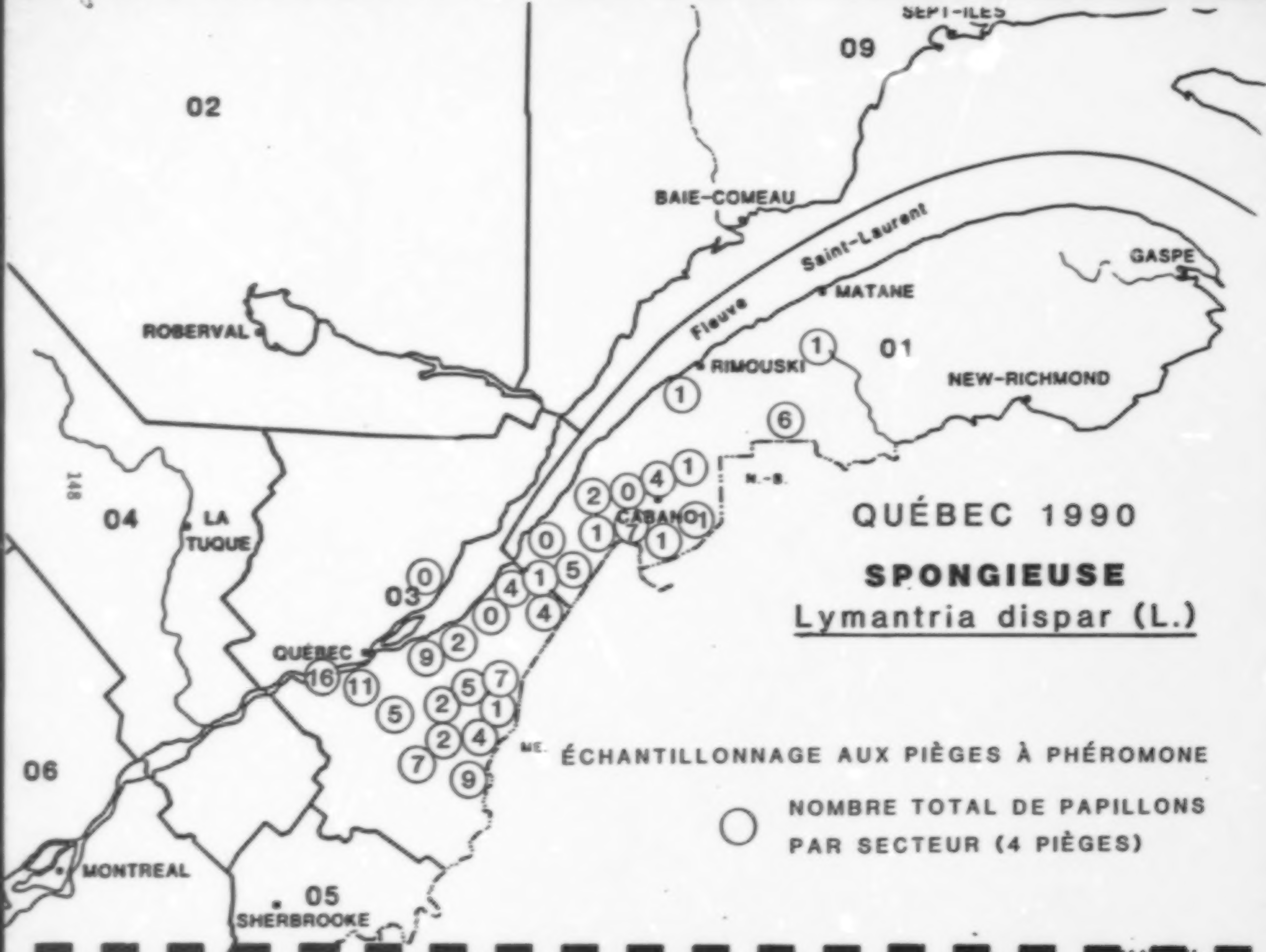
Gypsy moth (*Lymantria dispar* (L.))

IN 1990, THE INFESTATION COLLAPSED IN LAST YEAR'S MAIN AREA OF DEFOLIATION WHICH COVERED THEN SLIGHTLY OVER 1,000 HA, IN AND SOUTH OF GATINEAU PARK IN WESTERN QUEBEC. NORTH OF THIS PARK HOWEVER, NUMEROUS SMALL CENTERS OF LIGHT TO SEVERE DEFOLIATIONS, WERE FOUND THIS YEAR. THIS EXTENDS THE NORTHERLY DISTRIBUTION OF THE INSECT ALONG THE OUTAOUAIS RIVER. RED OAK AND LARGETOOTHED ASPEN WERE THE MAIN HOSTS AFFECTED.

IN CENTRAL QUEBEC, MAINLY IN MONTREAL AND TROIS-RIVIERES REGIONS THE INSECT ACTIVITY INCREASED SLIGHTLY IN MANY SMALL LOCAL STANDS OVER 1989, BUT DAMAGE WAS STILL RESTRICTED IN TERMS OF TOTAL AREA. MONT SAINT-HILAIRE, SOUTH OF MONTREAL, SUSTAINED A SEVERE DEFOLIATION OVER APPROXIMATELY 10 HA IN AN OAK STAND.

FIDS-LFC SET UP A PHEROMONE TRAPPING NETWORK IN 31 LOCATIONS LOCATED ON THE SOUTH SHORE OF THE SAINT-LAWRENCE RIVER, FROM QUEBEC CITY EASTWARD TO THE MATAPEDIA RIVER VALLEY (FIG. 1). AT EACH LOCATION FOUR TRAPS WERE SET, EACH ONE LOCATED AT LEAST 1 KM FROM ANOTHER, THE SPACING AVERAGING 2 KM.

THE CATCH OF MALE MOTHS WAS VERY LOW AS THE HIGHEST TOTAL FOR ONE LOCATION WAS 16 MOTHS, NEAR QUEBEC CITY. THIS CONCURS WITH THE VERY LOW POPULATION OF THE INSECT FOUND IN SOUTHERN QUEBEC IN RECENT YEARS AS WELL AS WITH THE BELIEF THAT THE INSECT IS NOT ESTABLISHED IN THIS PART OF THE PROVINCE.



SEPT-ILES
09
02
BAIE-COMEAU
Fleuve Saint-Laurent
GASPE
MATANE
ROBERVAL
01
RIMOUSKI
NEW-RICHMOND
N.-B.
CABANO
04
LA TUQUE
03
QUÉBEC
ME.
06
MONTREAL
05
SHERBROOKE
1
1
6
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QUÉBEC 1990

SPONGIEUSE

Lymantria dispar (L.)

ÉCHANTILLONNAGE AUX PIÈGES À PHÉROMONE

○ NOMBRE TOTAL DE PAPILLONS PAR SECTEUR (4 PIÈGES)

Large Aspen Tortrix (Choristoneura conflictana (Wlk.))

A NOTABLE INCREASE IN THE POPULATION OF THIS INSECT OCCURRED THIS YEAR IN THE SAGUENAY-LAC-SAINT-JEAN REGION. INFESTATION CENTERS WERE LOCATED MAINLY AT THE NORTH-WEST OF THE LAKE SAINT-JEAN AND ALONG THE SAGUENAY RIVER. OFTEN THERE WAS ALSO THE PRESENCE OF THE FOREST TENT CATERPILLAR IN THE SAME STANDS.

IN THE QUEBEC ADMINISTRATIVE REGION, THE INSECT IS STILL PRESENT IN MANY OF THE STANDS REPORTED AS AFFECTED IN 1989. NEW SITES WERE DEFOLIATED BETWEEN BAIE-SAINT-PAUL AND LA MALBAIE, ON THE NORTH SHORE. OVERALL, THE INFESTATION INCREASED SLIGHTLY IN AREA, BUT IT DECREASED IN SEVERITY, GOING GENERALLY FROM MODERATE-SEVERE TO LIGHT-MODERATE.

Spruce budmoth (Zeiraphera canadensis (Mut. & Free))

SIXTY-TWO PLANTATIONS WHERE THE INSECT WAS PRESENT IN 1989 IN THE GASPE PENINSULA, WERE REVISITED THIS YEAR. OVERALL, POPULATIONS DECREASED SLIGHTLY THIS YEAR. NO HIGH POPULATION LEVEL (MORE THAN EIGHT LARVAE PER 15 CM BRANCH) WAS FOUND.

Scleroderris canker (Gremmeniella abietina Lagerb. Morelet.)

THE PRESENCE OF THIS DISEASE WAS DETECTED IN LOTS OF JACK PINE IN SIX WIDELY SCATTERED PROVINCIAL NURSERIES IN QUEBEC IN SPRING 1990.

IN ONE LOCATION, ABOUT HALF A MILLION SEEDLINGS WERE DESTROYED DUE TO THIS PROBLEM. ELSEWHERE, INDIVIDUALLY INFECTED SEEDLINGS WERE REMOVED FROM THE LOTS AND THE REMAINING ONES OUTPLANTED, AS THE DISEASE WAS FOUND ONLY AT THE TRACE LEVEL.

TO DATE, LFC HAS RECEIVED 57 ISOLATES OF G. ABIETINA FROM THE SPIM-MER, FOR RACE TESTING. TWELVE ISOLATES OF JACK PINE (MANY COMING FROM THE ABOVE MENTIONED NURSERIES) TESTED NORTH-AMERICAN, NONE TESTED EUROPEAN. FOUR RED PINE ISOLATES TESTED NORTH AMERICAN AND TWO EUROPEAN. THERE REMAINS TO BE TESTED : 31 ISOLATES OF RED PINE, 4 OF JACK PINE, AND ONE EACH OF SCOTS PINE AND WHITE PINE.

Larch casebearer (Coleophora laricella (Hbn.))

MODERATE AND SEVERE DEFOLIATIONS BY THIS INSECT WERE REPORTED LOCALLY IN LOCALITIES SITUATED NORTH AND SOUTH OF MONTREAL. SOME OF THESE LOCALITIES ARE SAINT-JOVITE, SAINT-ADELE, MAGOG, MEGANTIC, BLAINVILLE, EASTMAN AND BROMONT.

Prepared by: Denis Lachance
FIDS Head
ForCan, Quebec Region

November 1990

DL/pc

RESULTS OF AERIAL TREATMENT WITH *BACILLUS THURINGIENSIS* AGAINST SPRUCE BUDWORM IN THE PRIVATE WOODLOTS IN EASTERN QUEBEC

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Québec region (Sainte-Foy)

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Syndicat des Producteurs de bois
du Bas Saint-Laurent

Eighteenth Annual Forest Pest Control Forum
Ottawa (Ontario)
November 1990

The 1990 spraying operation ensured a successful foliage protection throughout the 6 456 ha treated. The average maximum defoliation never exceeded 30% in any of the treated blocks but was an average of 73% in the untreated areas. Table 1 reports pretreatment and post-treatment population levels and current year growth defoliation for each block.

Figure 1 presents two curves illustrating defoliation distribution in treated and untreated areas for a pretreatment population ranging from 10 to 20 larvae per 45 cm branch tip.

The quality of the insecticide delivered forced us to withdraw 8 323 ha from the program in the Gaspé area. Also, 9 791 ha retained in the fall based on the L2 readings were discarded from the program in the spring since pre-treatment populations did not met our minimum requirement of 10 larvae/45 cm at L3.

Situation in the blocks were not included in the program. Entomological surveys and defoliation assessment were carried out in the untreated blocks to follow development of the spruce budworm outbreak (Table 2). The high level of defoliation observed in Sainte-Anne-des-Monts, Cap-Chat, Anse-à-Beaufils, Val d'Espoir, Sainte-Thérèse, Bougainville and Nouvelle revealed important population levels. In these localities, defoliation averaged 61.4%. On the north shore of the Gaspé Peninsula, from Gros-Morne to Petite Vallée, defoliation was low, from 2.9 to 12.0%, which indicated low population levels. For the first time, in many years, low populations levels were observed in the Matapedia River Valley where the defoliation also showed a high level of residual larval populations, up to 9.8 larvae/45 cm. An attentive follow-up should be carried out in these areas.

AERIAL SPRAYING OF Bacillus thuringiensis AGAINST SPRUCE BUDWORM
IN THE PRIVATE FOREST OF EASTERN QUEBEC

TABLE 1 RESULTS FOR 1990

AREA	BLOCKS	SAMPLE PLOT	PRE TREATMENT POPULATION LAR./45CM	RESIDUAL POPULATION LAR./45CM	DEFOLIATION (%)
GASPESIE	ROBIDOUX	115-03-01	10.40	1.00	14.30
	ROBIDOUX	115-04-01	10.60	0.40	26.70
	ROBIDOUX	115-05-01	8.20	4.80	44.60
		115-05-02	19.40	2.20	34.00
		TEMOIN #1	13.20	6.20	73.00
		TEMOIN #2	14.40	5.40	80.30
	NEW-RICHMOND	115-07-01	23.80	1.40	46.80
		115-07-02	11.80	1.20	21.10
		TEMOIN #1	13.20	6.20	73.00
		TEMOIN #2	14.40	5.40	80.30
	NOUV. ESCUMINAC	115-12-03	7.60	0.20	14.60
		TEMOIN #1	8.80	1.40	54.30
	ESCUMINAC-GLENN	115-13-01	11.00	2.00	33.54
		TEMOIN #1	9.80	1.40	54.30
	GR. CASCAPEDIA	115-15-01	22.80	1.60	48.70
		115-15-02	8.60	3.60	22.70
		TEMOIN #1	18.40	3.40	65.30
B.S.L.	ASCENSION	129-01-01	10.60	0.20	11.10
		129-01-02	9.40	1.20	18.30
		TEMOIN #1	13.60	5.20	77.70
		TEMOIN #2	17.40	5.20	67.10
	ST-FRANCOIS	129-03-01	7.80	1.20	3.60
		129-03-02	12.60	2.60	17.80
		TEMOIN #1	13.60	5.20	77.70
		TEMOIN #2	17.40	5.20	67.10

AERIAL SPRAYING OF Bacillus thuringiensis AGAINST SPRUCE BUDWORM
IN THE PRIVATE FOREST OF EASTERN QUEBEC

TABLE 1 BLOCKS EXCLUDED FROM THE SPRAY PROGRAM AND USED TO FOLLOW
SPRUCE BUDWORM OUTBREAK DEVELOPPEMENT

AREA	BLOCKS	SAMPLE PLOT	PRE TREATMENT POPULATION LAR./45CM	RESIDUAL POPULATION LAR./45CM	DEFOLIATION (%)
GASPESIE	CAP-CHAT	111-01-01	11.60	2.40	20.00
	CAP-CHAT	111-02-01	12.60	5.80	61.40
		111-02-02	11.80	2.80	43.90
		111-02-03	6.40	1.00	21.90
		111-02-04	25.60	3.40	50.40
	STE-ANNE DES MONTS	111-04-01	14.20	2.80	51.30
	GROS-MORNE	111-12-01	2.60	0.00	6.10
		111-12-02	3.20	0.20	3.40
	MANCHE D'EPEE	111-13-01	4.00	0.00	7.30
		111-13-02	4.40	0.00	5.20
		111-13-03	5.60	0.20	6.90
	MADELEINE CENTRE	111-14-01	6.60	0.20	12.00
	MANCHE D'EPEE	111-16-01	3.00	1.00	6.20
	PTE A LA RENOMMEE	112-02-01	1.40	0.20	6.70
		112-02-02	1.00	0.00	10.90
	PTE A LA FREGATE	112-04-01	0.60	0.00	2.90
	PETITE-VALLEE	112-05-01	1.40	0.20	5.50
	VAL D'ESPOIR	114-01-01	16.80	4.00	57.60
		114-01-02	33.60	7.00	52.50
	ANSE A BEAUFILS	114-02-01	12.20	3.40	45.70
	STE-THERESE	114-03-01	20.40	9.80	57.20
	NEWPORT	114-04-01	3.60	1.80	12.00
		114-04-02	1.40	0.00	9.10

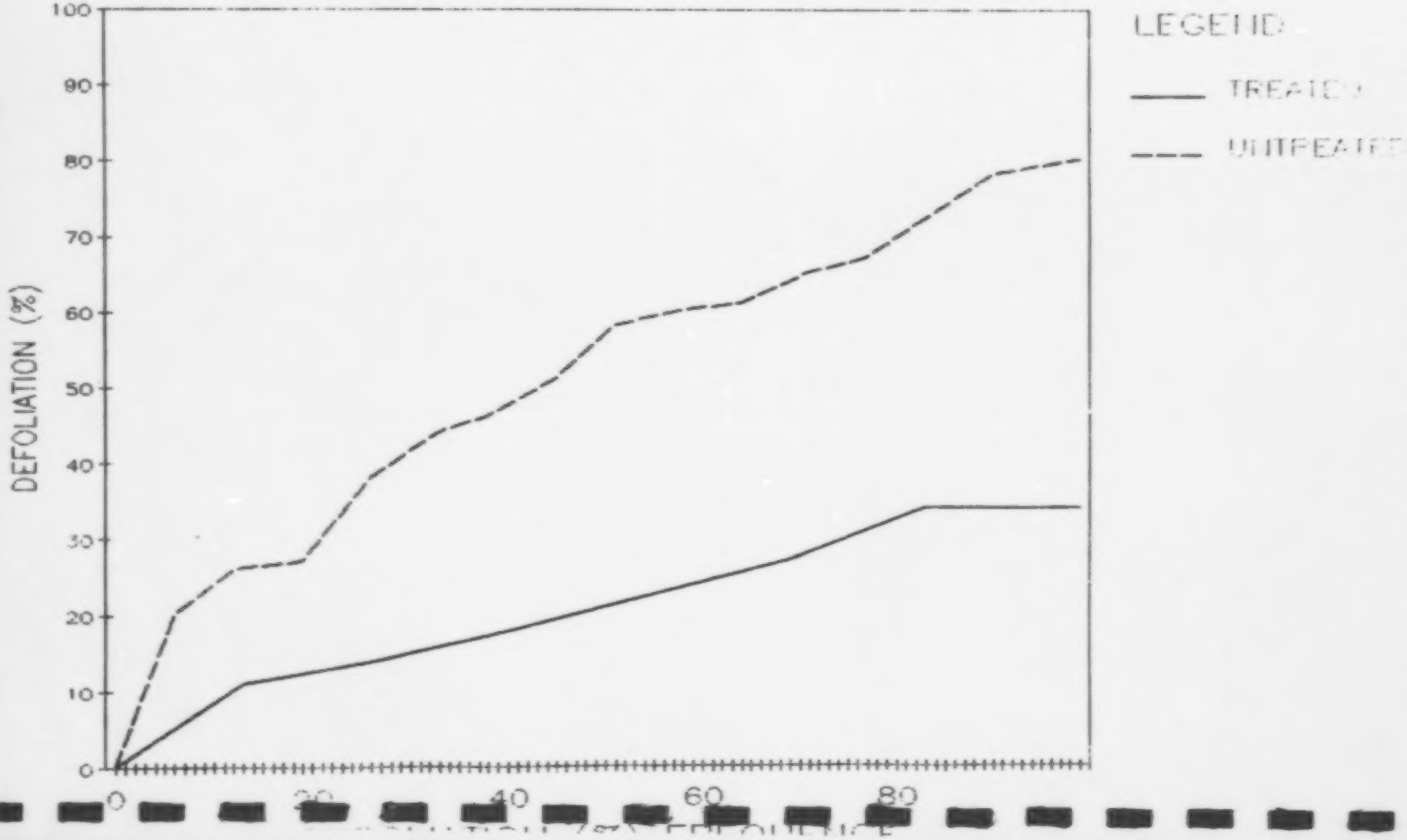
AERIAL SPRAYING OF *Bacillus thuringiensis* AGAINST SPRUCE BUDWORM
IN THE PRIVATE FOREST OF EASTERN QUEBEC

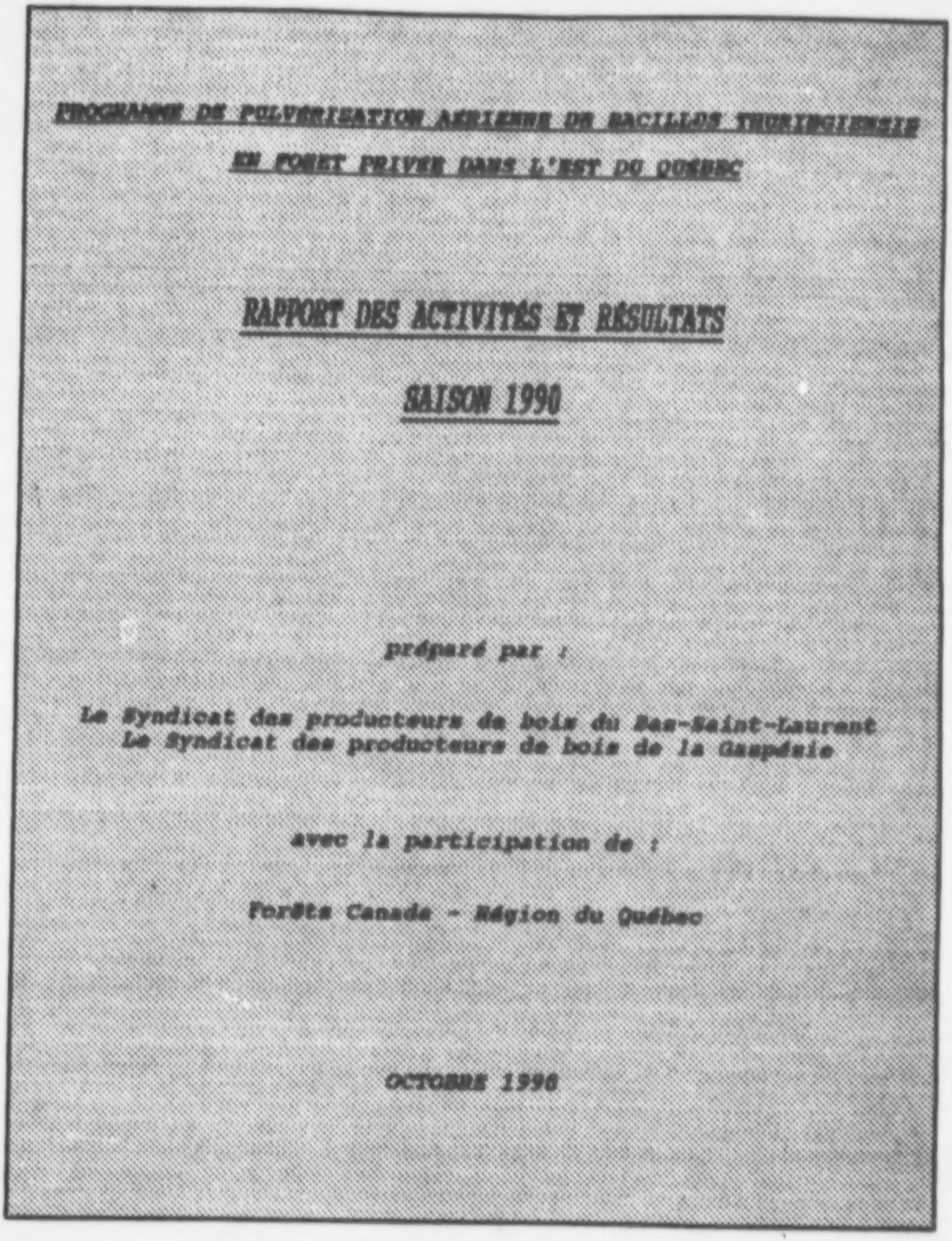
TABLE 1 BLOCKS EXCLUDED FROM THE SPRAY PROGRAM AND USED TO FOLLOW SPRUCE BUDWORM OUTBREAK DEVELOPPEMENT

Cont'd

AREA	BLOCKS	SAMPLE PLOT	PRE TREATMENT POPULATION LAR./45CM	RESIDUAL POPULATION LAR./45CM	DEFOLIATION (%)
	BOUGAINVILLE	114-05-01	12.60	2.60	25.90
		114-05-02	11.20	3.20	37.60
	ST-ELZEAR	115-01-01	3.00	3.00	5.30
		115-01-02	4.40	2.00	8.30
		115-01-03	2.00	2.00	17.00
	ST-SIMEON	115-02-01	9.20	1.60	34.00
		115-02-02	4.20	3.00	33.20
	NOUV. V. ALLARD	115-11-01	10.40	4.00	59.80
	BREBOEUF	115-16-01	10.40	2.40	26.80
B.S.L.	STE-MARGUERITE	128-02-01	1.80	0.20	4.20
		128-02-02	1.60	0.20	1.50
	ALBERTVILLE	128-06-01	3.60	1.20	11.20
		128-06-02	1.40	0.60	10.70
		128-06-03	4.60	1.20	25.00
	STE-IRENE	128-07-01	4.20	0.40	6.70
		128-07-02	1.80	0.00	3.90
		128-07-03	2.20	0.00	7.30
		128-07-04	8.40	1.20	4.90

DEFOLIATION (%) DISTRIBUTION IN TREATED AND UNTREATED BLOCKS (10-20 LARVAE/BRANCH TIP) 1990





PROGRAMME DE PULVERISATION AERIENNE DE BACILLUS THURINGIENSIS
EN FORET PRIVEE DANS L'EST DU QUÉBEC

RAPPORT DES ACTIVITÉS ET RÉSULTATS

SAISON 1990

préparé par :

Le Syndicat des producteurs de bois du Bas-Saint-Laurent
Le Syndicat des producteurs de bois de la Gaspésie

avec la participation de :

Forêts Canada - Région du Québec

OCTOBRE 1990

Original French Report is available on request

RÉSUMÉ

L'opération 1990 fut, en termes de protection des blocs traités, une réussite. Six mille quatre-cent-cinquante-six hectares de forêt furent pulvérisés au B.t. La défoliation du feuillage de l'année ne dépasse pas 30% dans les blocs traités versus 80% dans les témoins.

Toutefois, des problèmes d'approvisionnement en insecticide ont empêché la protection de 8 323 hectares de forêt privée situés dans le territoire du Syndicat des producteurs de bois de la Gaspésie.

De plus, 9 791 hectares des 24 570 retenus pour traitement au printemps 1990 ont dû être retranchés du programme car, à l'intérieur de ceux-ci, le nombre d'insectes ne rencontrait pas la norme minimale exigeant un traitement, soit 10 larves par branche de 45cm.

THE SPRUCE BUDWORM IN QUEBEC

1990

- The 1990 spray program
- State of the epidemic in 1990
- Forecast for 1991

Ministère de l'Energie et des Ressources
Direction de la conservation

Service de la protection contre
les insectes et les maladies

Louis Dorais, For. Eng., M.Sc.
Service Head

Division de l'évaluation
des programmes

Michel Auger, For. Eng.
Division Head

October 1990

I THE 1990 SPRAY PROGRAM

1. Areas treated

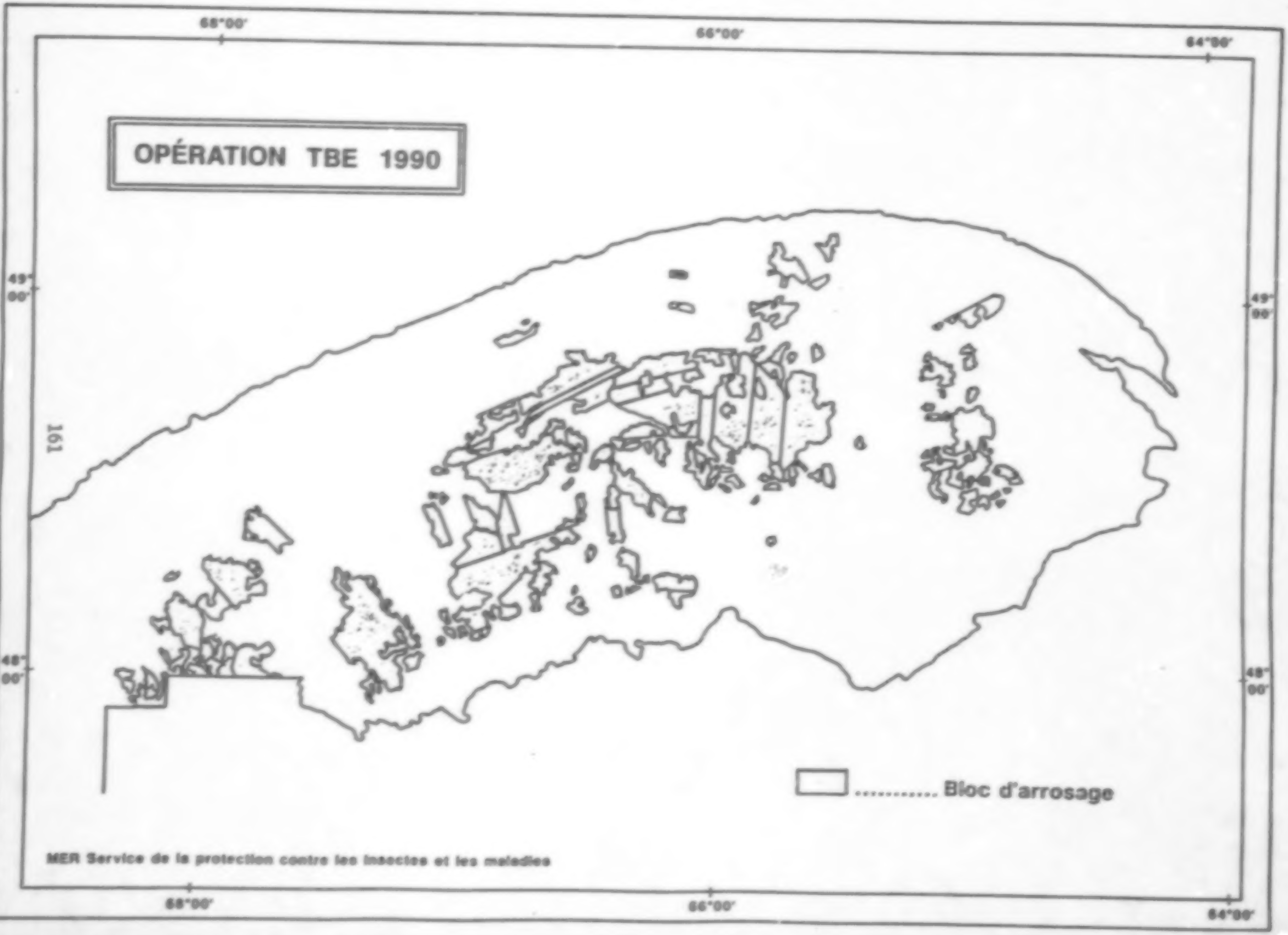
The 1990 spray program was expected to cover a total area of 531 193 hectares, or three times more than the area treated in 1989. Given the high larval populations predicted for half of this area, the ministère de l'Energie et des Ressources had planned a more aggressive strategy, with a double application of insecticide.

Poor weather conditions considerably delayed the spray operations and treatment had to be cancelled on 103 651 hectares. The 1990 spray program was therefore carried out on a total surface area of 479 896 hectares, of which 211 809 hectares received a double application (Fig. 1).

2. The insecticides

For the fourth consecutive year, the biological insecticide, *Bacillus thuringiensis* var. kurstaki (B.t.), was used throughout the spray area. Four different biological products were sprayed undiluted at a rate of 30 billion international units (BIU) per hectare, for a volume of 0.9 to 2.37 l/ha, depending on the potency of each product.

FIG. 1 : SUPERFICIES TRAITEES CONTRE LA TORDEUSE DES BOURGEONS DE L'EPINETTE EN 1990.


OPÉRATION TBE 1990
68°00'
66°00'
64°00'
49° 00'
48° 00'
.... Bloc d'arrosage

MER Service de la protection contre les insectes et les maladies

Product	Potency		Volume/ha	Area
	IU/mg	BIU/l	l/ha	ha
Dipel 176	17 600	16.9	1.77	567 198
Futura XLV HP	28 700	33.0	0.90	110 673
Foray 48B	12 600	12.7	2.37	6 917
Biodart	15 650	16.9	1.77	6 917

3. Insecticide spraying

With the cold weather of May and early June, treatment began 6 days later than in 1989. The spray program was spread over a period of 26 days, from June 8 until July 3. Weather conditions were suitable for spraying during only 18 of the total 47 spray sessions, i.e., for only 38% of the possible sessions.

Nine four-engine planes (5 DC-6s and 4 DC-4s), flying out of Mont-Joli and Bonaventure, sprayed almost one million litres of insecticide. Nineteen single-engine planes (3 Pawnees, 12 Agcats, 2 Thrush 800s and 2 Turbo Thrushes) were also used, flying out of six small airports in the Gaspé Peninsula (Rimouski, Causapscal, Nouvelle, Lac la Ferme, Murdochville and Sainte-Anne-des-Monts).

The 1990 spray program required a total budget of approximately $18 million, and the average cost per hectare was $27.50 for one application and $45.50 for two.

4. Timing

Spray timing is based on observations of fir bud flare and spruce budworm development (Fig. 2). The commencement of treatment must coincide with a bud flare index of more than 3.8. In this, timing was excellent for the 1990 insecticide applications (Table 1). Nonetheless, poor weather conditions delayed the beginning of treatment in several blocks and generally hampered the spray operations. On 32% of the total spray area, treatment was delayed more than ten days beyond the opening date and, on 30% of the spray area, the first insecticide application took place when budworm development was advanced (> 5.5). More than half of the treated areas (53%) had attained a defoliation rate greater than 20% by the time they received the first application of insecticide. In the worst cases, which represent 11% of the total area treated, annual growth defoliation was 60% by the time treatment began (Fig. 3 and 4).

Spraying was cancelled in some blocks once the first chrysalids had appeared. Because of this, the planned second application of insecticide could not be done on 52 177 ha, while a similar area (51 474 ha) received no treatment at all.

5. Pre-spray larval populations

The average larval population in the treated sectors was 18.1

FIG. 2 : **COURBES DE DÉVELOPPEMENT DE LA TORDEUSE DES BOURGEONS DE L'ÉPINETTE ET DE L'ÉTALEMENT DE LA POUSSE DU SAPIN EN 1989 ET 1990 POUR LA RÉGION D'AMQUI**

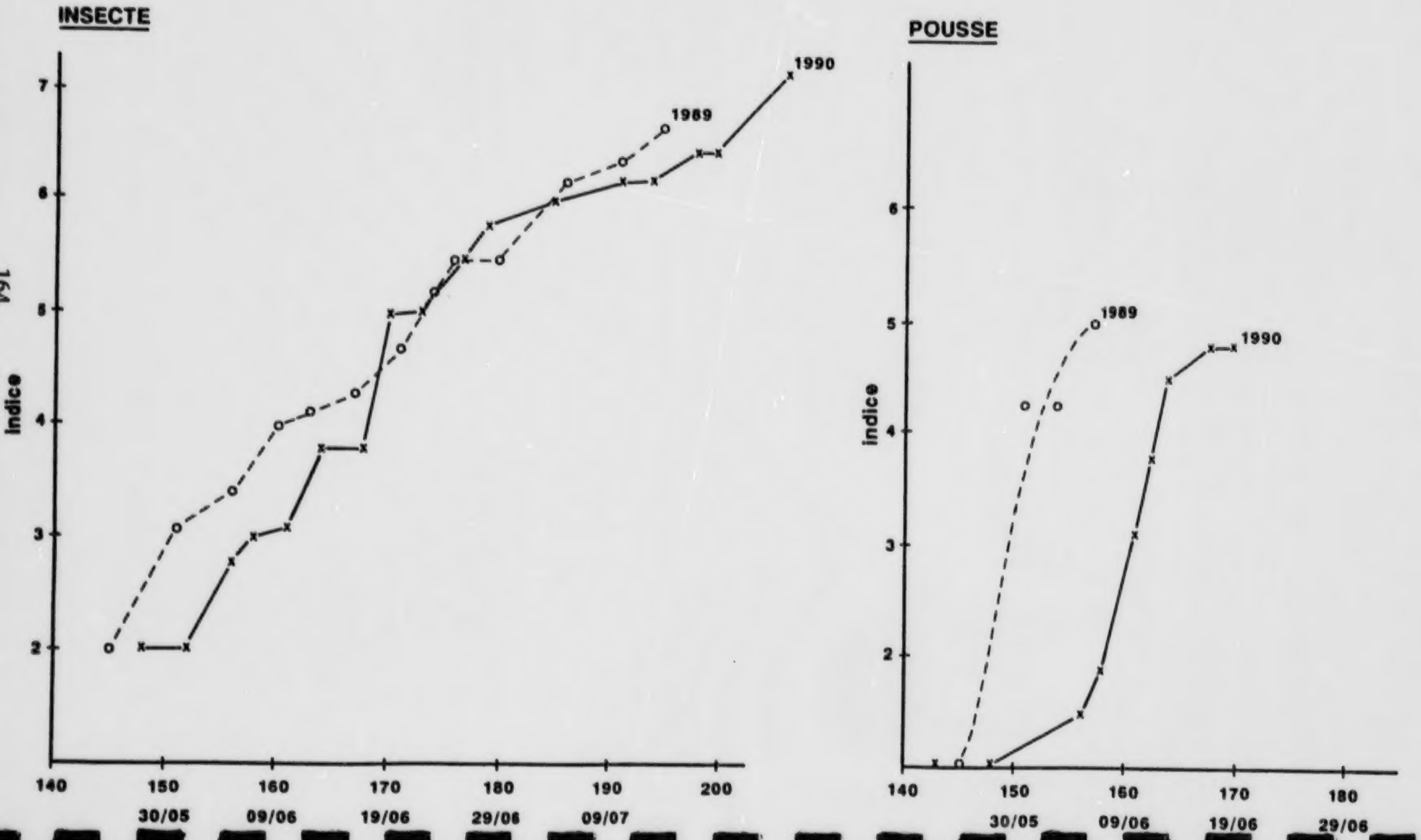


TABLEAU 1

Pourcentage du territoire traité en 1990
contre la tordeuse des bourgeons de l'épinette,
choristoneura fumiferana (Clem),
en fonction de l'étalement de la pousse et du
développement de l'insecte.

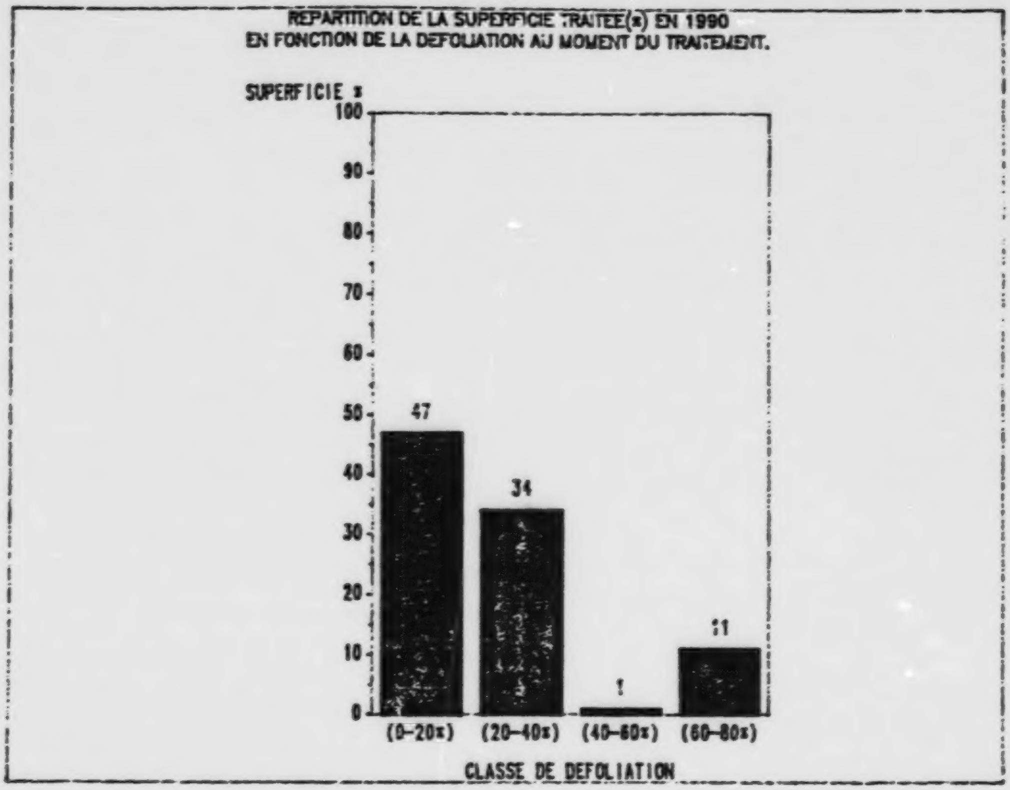
Etalement de la pousse

Indice	1ere application	2ième application
2.5 - 3.0	3	
3.1 - 3.5	2	
3.6 - 4.0	20	
4.1 - 4.5	12	
4.6 - 5.0	63	100

Développement de l'insecte

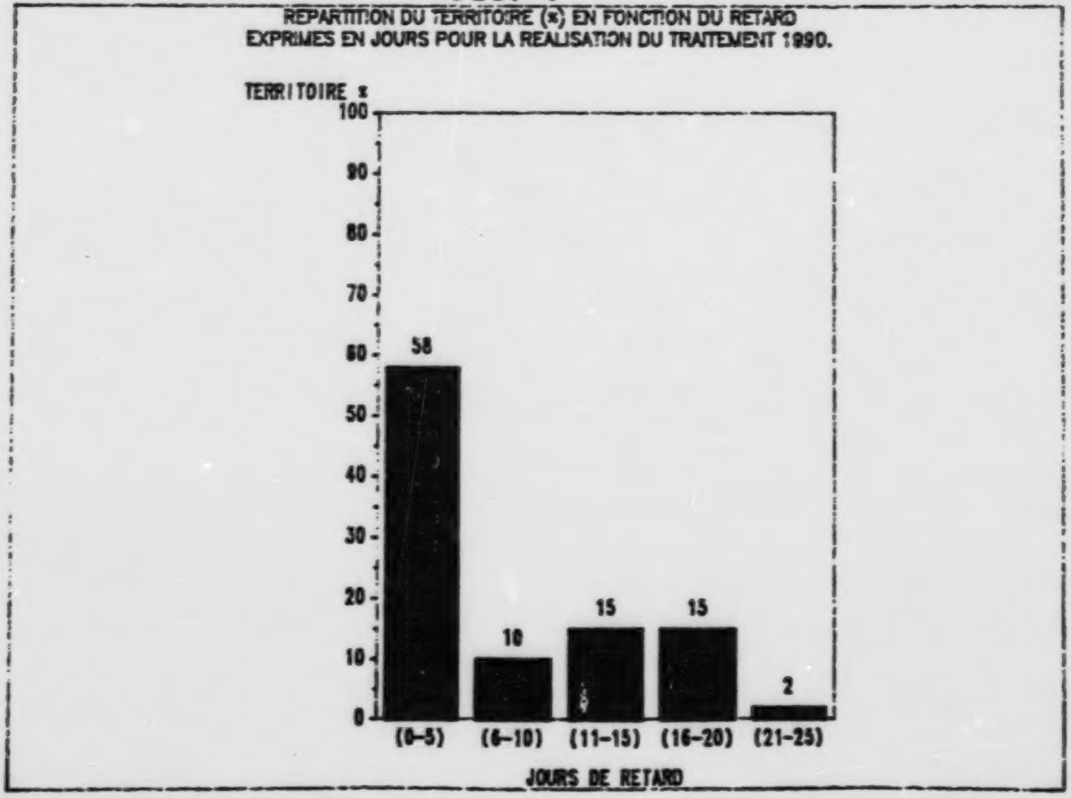
Indice	1ere application	2ième application
2.5 - 3.0	0	0
3.1 - 3.5	9	0
3.6 - 4.0	30	0
4.1 - 4.5	16	2
4.6 - 5.0	9	12
5.1 - 5.5	6	38
5.6 - 6.0	30	48

FIG. 3



REPARTITION DE LA SUPERFICIE TRAITEE(x) EN 1990
EN FONCTION DE LA DEFOLIATION AU MOMENT DU TRAITEMENT.

FIG. 4



REPARTITION DU TERRITOIRE (x) EN FONCTION DU RETARD
EXPRIMES EN JOURS POUR LA REALISATION DU TRAITEMENT 1990.

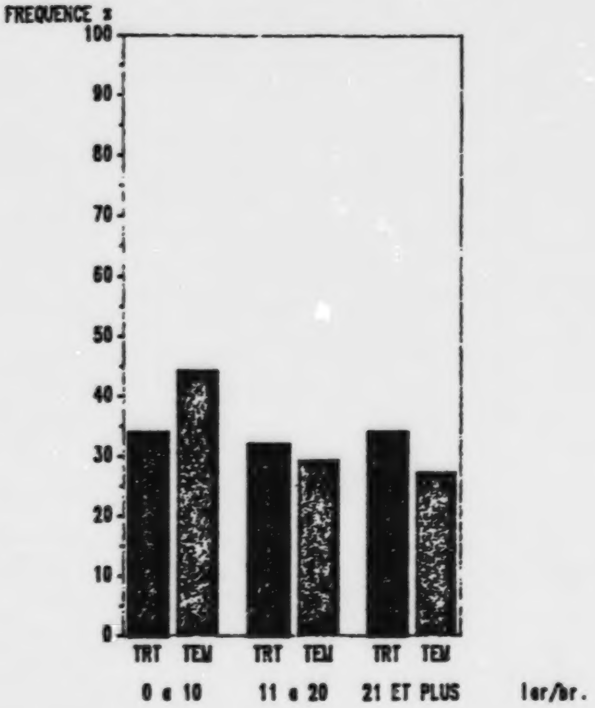
larvae per branch, compared to 17.8 in 1989. Almost 37% of the sample plots set up to assess treatment efficacy registered a larval population of more than 20 larvae per 45-cm branch, while in 35% of the plots, the population was less than 10 larvae per branch (Fig. 5). This distribution of the larval population in 1990 is more or less the same as in 1989. The proportion of sample plots showing high larval populations was slightly higher this year. According to the larval populations observed prior to treatment, the heavily infested areas represented 55% of the area covered by the 1990 spray program. In sectors with a low infestation level (7% of the total treated area), spraying was aimed primarily at maintaining the larval populations at a low or moderate level, or at reducing them to such a level, so as to avoid high populations next year (treatment being often less effective in such instances).

6. Defoliation prediction curve

A defoliation prediction curve was drawn, using the larval populations recorded in 205 untreated sample plots (Fig. 6). The curve made it possible to assess the effectiveness of the spray operations in terms of annual foliage protection. The prediction curve obtained in 1990 differs significantly from that obtained in 1989, primarily because of population densities lower than 0.2 larvae per bud. It is difficult to explain the variations noted from one year to the next.

FIG. 5 : REPARTITION DES POPULATIONS LARVAIRES DE LA TORDEUSE DES BOURGEONS DE L'EPINETTE EN 1989 et 1990.

1989



1990

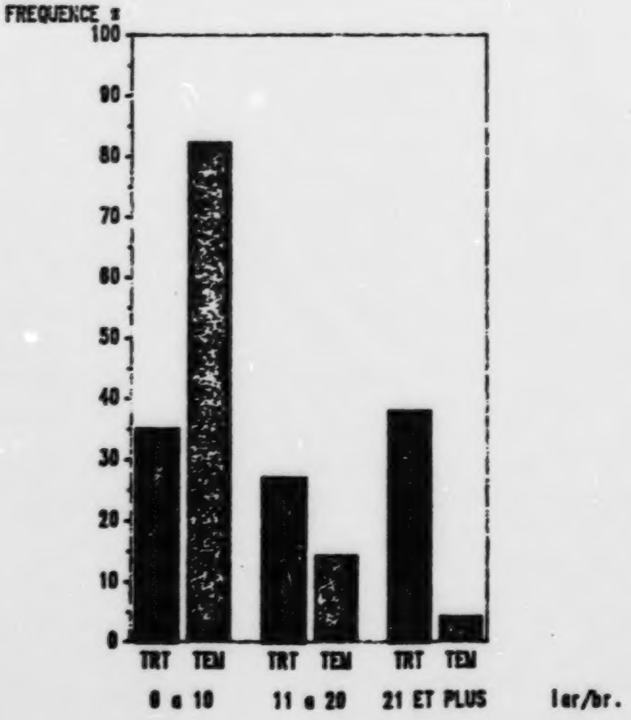
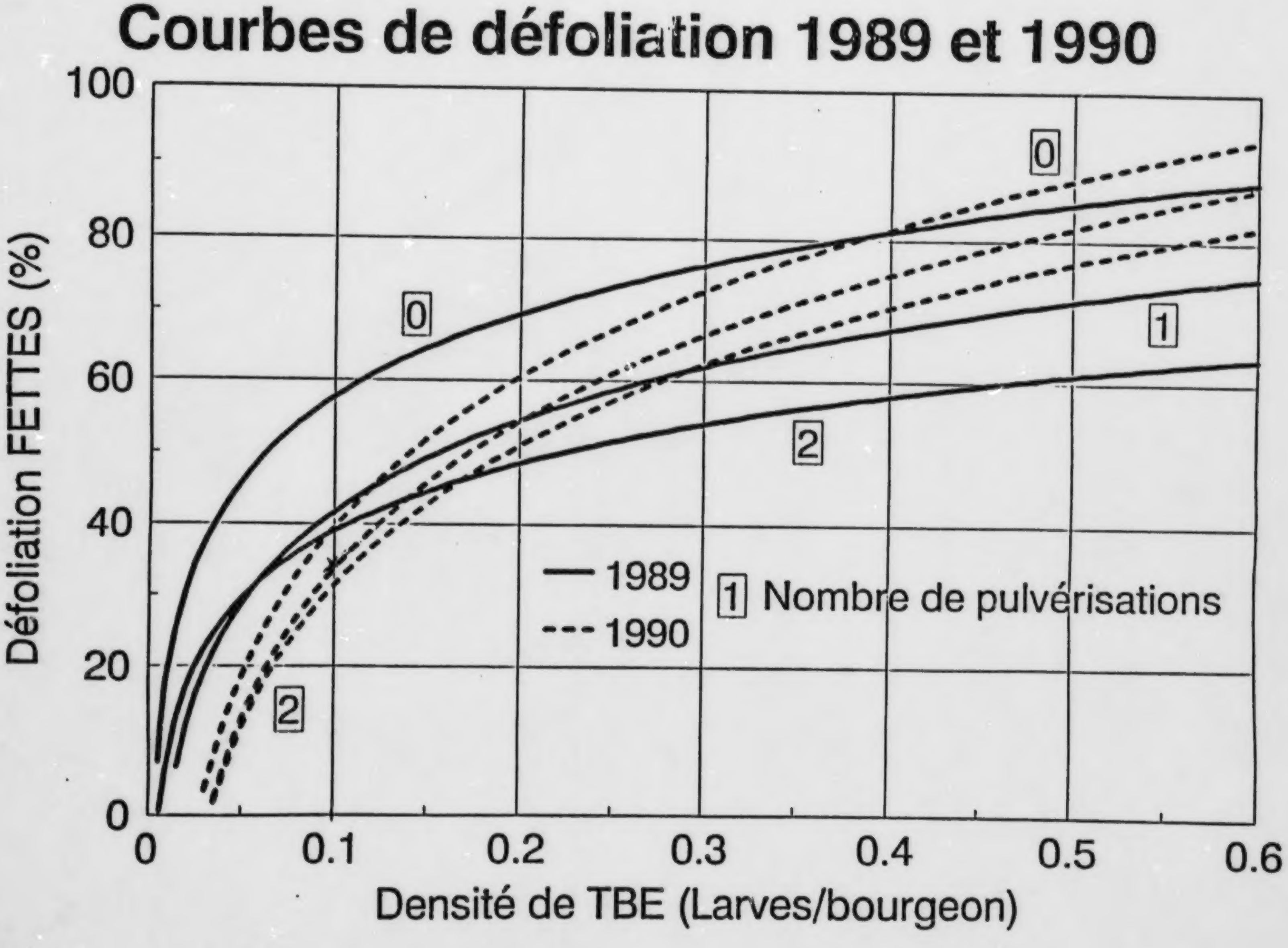


FIG. 6 : COURBE DE PREVISION DE LA DEFOLIATION A L'INTERIEUR ET A L'EXTERIEUR DES AIRES TRAITEES EN 1989 et 1990.



Budworm behaviour and vitality, food quality, and sampling are often cited as possible explanatory factors.

7. Results, by number of applications

In sectors with a larval population higher than 20 larvae per branch, defoliation reduction was twice as high (17.7% and 9.9%) in the sample plots that received a double application of insecticide. Defoliation of annual growth was 78% with one application and 70% with two (Table 2).

The second application of insecticide, carried out when the insect had reached an advanced stage of development, significantly reduced the budworm population (99.5%). The mortality that resulted from a double application of insecticide was twice as high as that achieved with a single application (69.2%, as compared to 31.8%).

In less heavily infested stands (10 to 20 larvae), a second application of insecticide had no significant effect on foliage protection, but did result in a considerable reduction of the budworm population (Table 2).

8. Results, by biological product

The performance of the biological product Futura XLV-HP was considerably weaker than that of Dipel 176 and Foray 48B.

Tableau 2: Mortalité larvaire et réduction de la défoliation obtenues en 1990, dans les secteurs traités contre la tordeuse des bourgeons de l'épinette, _Choristoneura_ _fumiferana_ (Clem.) en fonction des traitements et des niveaux de population.

Traitement	Niveau de population	N	Populations		% mortalité		% défoliation			% réduction défoliation[3]	
			Pré	Post	finale	corrigée[1]	Prévue[2]	obs.	réduction		
2 X 30	0-10	161	6.3	0.5	97.1 ab	66.7 a	21.1	32.2	-11.2 d	-16.5	(26.0)
	11-20	185	15.4	0.5	99.2 a	71.0 a	59.6	46.7	12.9 ab	20.5	(33.8)
	21 +	237	40.7	0.8	99.5 a	69.2 a	88.2	70.5	17.7 a	20.5	(38.3)
1 X 30	0-10	529	4.3	0.4	87.5 c	30.3 b	18.0	17.9	0.1 c	5.2	(37.6)
	11-20	238	15.2	1.3	96.0 ab	33.0 b	59.1	47.0	12.0 ab	19.6	(23.7)
	21 +	344	39.6	1.7	97.4 ab	31.8 b	87.9	78.0	9.9 b	11.5	(15.2)
TÉMOIN	0-10	784	3.2	0.5	76.1 d	0 c	15.8	15.8	0 c	0	0
	11-20	133	14.3	1.8	91.2 bc	0 c	56.7	56.7	0 c	0	0
	21 +	111	37.1	2.7	94.3 abc	0 bc	86.5	86.5	0 c	0	0

[1] 100 X (mortalité traitement - mortalité témoin) / (100 - mortalité témoin).

[2] Selon un modèle de prévision utilisant la densité (larves/bourgeon) initiales des larves de T.B.E.

[3] 100 X (défoliation prévue - Fettes observée) / défiliation prévue.

( ) % réduction défoliation 1989.

Note: Pour une même variable, les valeurs suivies de lettres différentes sont significativement différentes (Tukey-Kramer, a = 0.05).

Futura XLV-HP, a highly concentrated product, was sprayed at a volume of 0.9 l/ha. It was impossible to adequately assess the effectiveness of Biodart, as the areas treated were very small and there were not enough sample plots.

Foray 48 and Dipel 176 reduced defoliation by 14% and 7%, respectively, and these results proved to be statistically comparable. Foray 48B was applied at a volume of 2.37 l/ha, and Dipel 176 at a volume of 1.77 l/ha (Table 3).

A double application of Dipel 176 over most of the heavily infested sectors resulted in a defoliation reduction of 11%. Sectors treated twice with Foray 48B and Futura XLV-HP were not adequately protected. It was impossible to do a reliable assessment of these two treatments because of limited sampling and the small area involved.

9. Results, by type of aircraft

The air survey done in 1990 revealed that annual defoliation varied between light and moderate in 70% of the area and was severe in 30%. The treatments provided adequate annual growth protection over 60% of the treated area. Defoliation was reduced from severe to moderate in 48% of the total area, and from severe to light in 12%. For 10% of the spray area, the aim of the treatment was to maintain the larval population at

Tableau 3 : Mortalité larvaire et réduction de la défoliation obtenues en 1990, dans les secteurs traités contre la tordeuse des bourgeons de l'épinette, Choristoneura fumiferana (Clem.) en fonction des traitements et des produits.

Traitement	Produit	N	Populations		% mortalité		%défoliation[3]			%réduction
			Pré	Post	finale	corrigée[1]	prévue[2]	obs.	réduction	défoliation
1 X 30	Dipel 176	875	16.1	0.9	92.3 b	30.2 b	45.7	39.1	6.6 a	14.0 b
	Futura XLV	182	25.5	1.5	95.2 b	32.3 b	61.4	62.5	-1.2 b	-12.7a c
	Foray 48B	49	16.4	1.0	96.8ab	40.9 b	53.1	39.2	13.8 a	24.9ab
2 X 30	Dipel 176	459	22.8	0.3	99.5a	78.4a	59.7	48.9	10.9 a	18.0 b
	Futura XLV	94	22.5	1.9	93.8 b	23.3 b	60.5	64.6	-4.1 b	-19.9 c
	Foray 48B	5	34.8	1.0	98.3ab	46.9ab	83.2	96.4	-13.2 ab	-17.6 bc

[1] 100 X (mortalité traitement - mortalité témoin) / (100 - mortalité témoin).

[2] Selon un modèle de prévision utilisant la densité (larves/bourgeon) initiale des larves de T.B.E.

[3] 100 X (défoliation prévue - Fettes observée) / défoliation prévue.

Note: Pour une même variable, les valeurs suivies d'une même lettre ne sont pas significativement différentes (Tukey-Kramer, a = 0.05).

a low level, as a reemergence of the epidemic was feared. No major damage was expected in this portion of the area.

11. Reduction of the budworm population for 1991

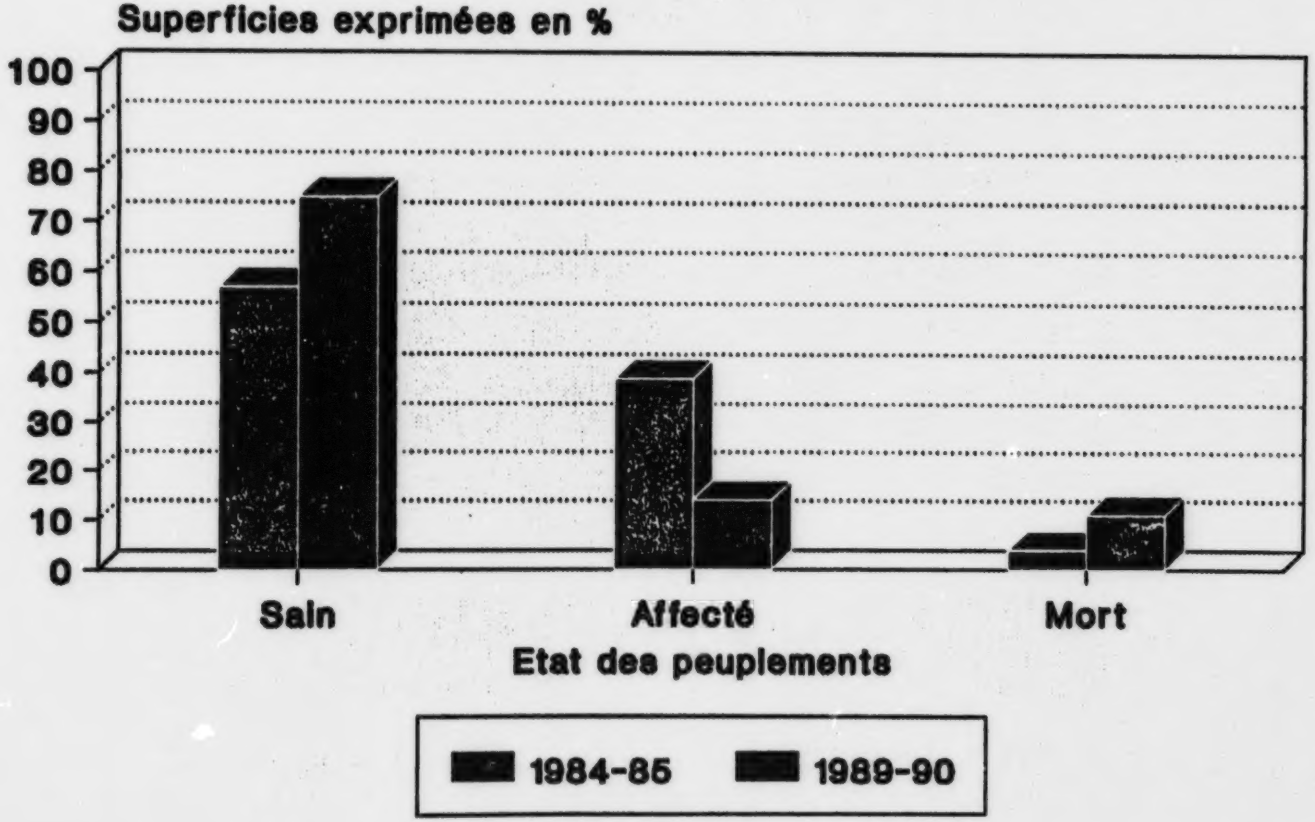
In the heavily infested sectors, which represented 55% of the treated area, there was a sharp reduction in population as a result of treatment, except for a small portion of the area (10%) where larval populations will be high in 1991. In the severely defoliated sectors that were not sprayed, 60% of the sampled sites were found to have high and very high population levels, compared to a proportion of only 13% in the severely defoliated zones that were sprayed.

12. Condition of the stands in treated sectors

The state of the forest was assessed, using data gathered during helicopter flights and from satellite images. Comparisons were drawn between data gathered in 1984-1985 and those gathered in 1989-1990, for both forest sectors under the spray program and others not included in the program.

The forests which have received treatment are currently faring better than they were in 1985 (Fig. 7). Areas recording a significant mortality rate have increased by barely 1% per year since 1985, while a major recovery program outside the treated

FIG. 7 : Evolution de la forêt à l'intérieur des secteurs éligibles aux pulvérisations



Forêts publiques sous production forestière et grands terrains privés
(feuillets 22A,22B,22C,22G,22H)

Octobre 1990

areas has made it possible to harvest almost half of the areas seriously affected by mortality in 1985.

13. Conclusions

The 1990 insecticide spray program provided adequate annual foliage protection in 60% of the area treated. No effort was spared in trying to ensure that the 1990 program would be a success. The number of planes was increased, so that infested stands could be sprayed quickly before damage appeared, and a second application was added in heavily infested sectors so as to ensure better protection.

The low foliage protection results obtained in 1990 on 30% of the treated area were in large part caused by both poor weather conditions, which significantly delayed and hampered operations, and by dense larval populations. Despite this, the treatments conducted this year, and particularly the double application of insecticide, greatly reduced the larval populations in heavily affected areas.

The results show that the long-term efficacy of the spray programs of the past few years has been sufficient to maintain the stands in good condition and to avoid tree mortality.

B.t. is recognized as being effective against certain levels of budworm population. Despite the addition of a second application of insecticide, it was not possible to demonstrate B.t. efficacy in sectors heavily infested in 1990. We still feel that the formula needs to be perfected and that more research should be carried out with new B.t. formulations to increase the effectiveness of this treatment.

II. STATE OF THE EPIDEMIC IN 1990

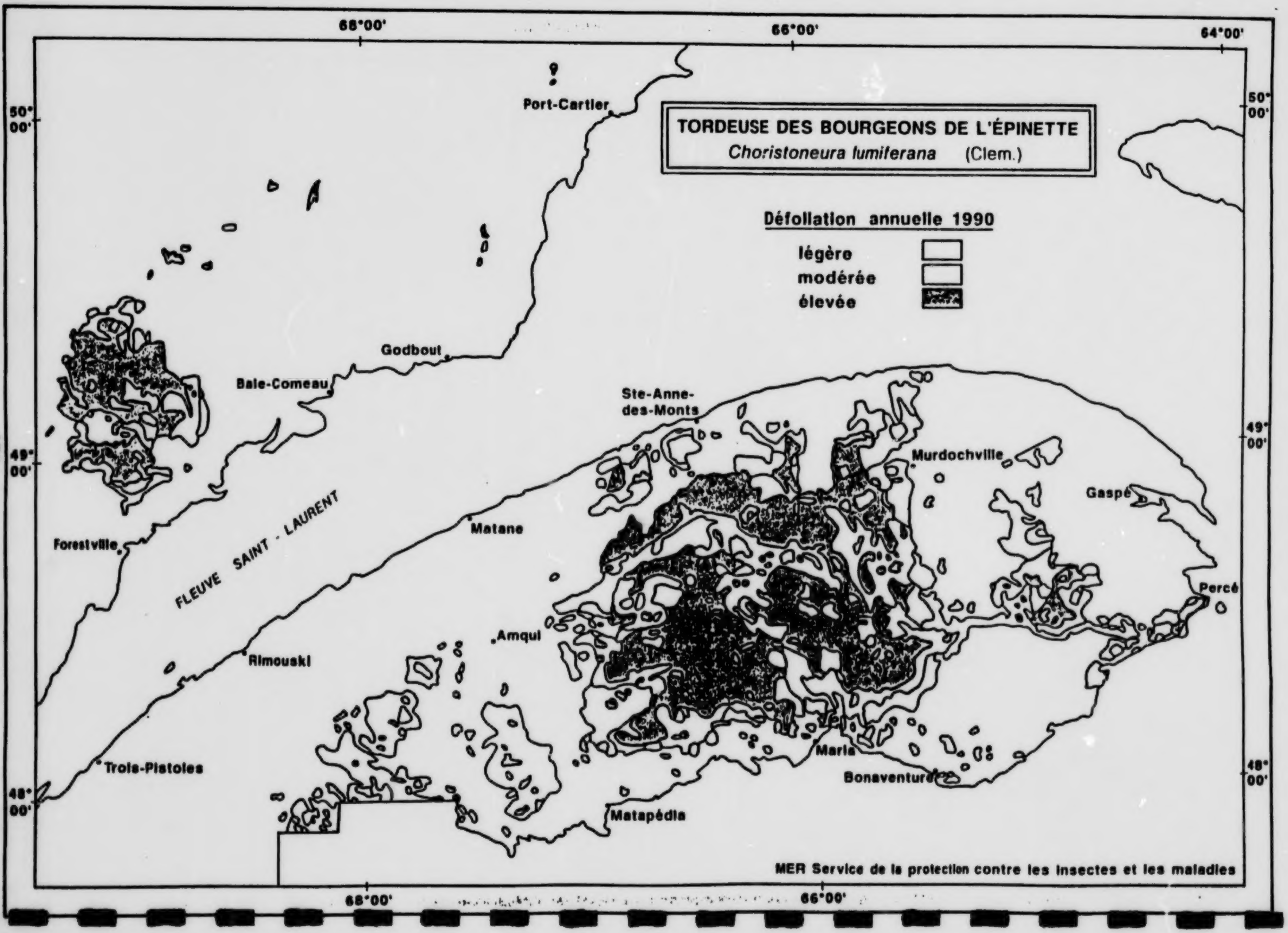
The spruce budworm infestation continued to develop in the Gaspé Peninsula and Côte-Nord region. In 1990, the infestation covered a total area of 1.25 million hectares, of which almost 1.1 million were in the Gaspé Peninsula. Damage was light over 0.38 million hectares, moderate over 0.31 million hectares and severe over 0.56 million hectares (Fig. 8).

On a provincial scale, the infested areas have increased by 26% over 1989. This rate was 25% in the Bas-Saint-Laurent-Gaspésie region and 37% in the Côte-Nord region.

For a second consecutive year, damage was very heavy in the Gaspé Peninsula. The attack was also stronger this year in the Côte-Nord region.

Monitoring in the Outaouais region has confirmed the presence of low larval populations comparable to those recorded in 1989. In the other regions, the budworm population has remained at its endemic level.

FIG. 8 : SUPERFICIES INFESTEES PAR LA TORDEUSE DES BOURGEONS DE L'EPINETTE EN 1990.


TORDEUSE DES BOURGEONS DE L'ÉPINETTE
Choristoneura fumiferana (Clem.)
Défoliation annuelle 1990
légère
modérée
élevée
68°00'
66°00'
64°00'
50° 00'
49° 00'
48° 00'
Port-Cartier
Godbout
Baie-Comeau
Forestville
FLEUVE SAINT - LAURENT
Ste-Anne-des-Monts
Matane
Amqui
Rimouski
Trois-Pistoles
Murdochville
Gaspé
Percé
Maria
Bonaventure
Matapédia

MER Service de la protection contre les insectes et les maladies

III. FORECAST FOR 1991

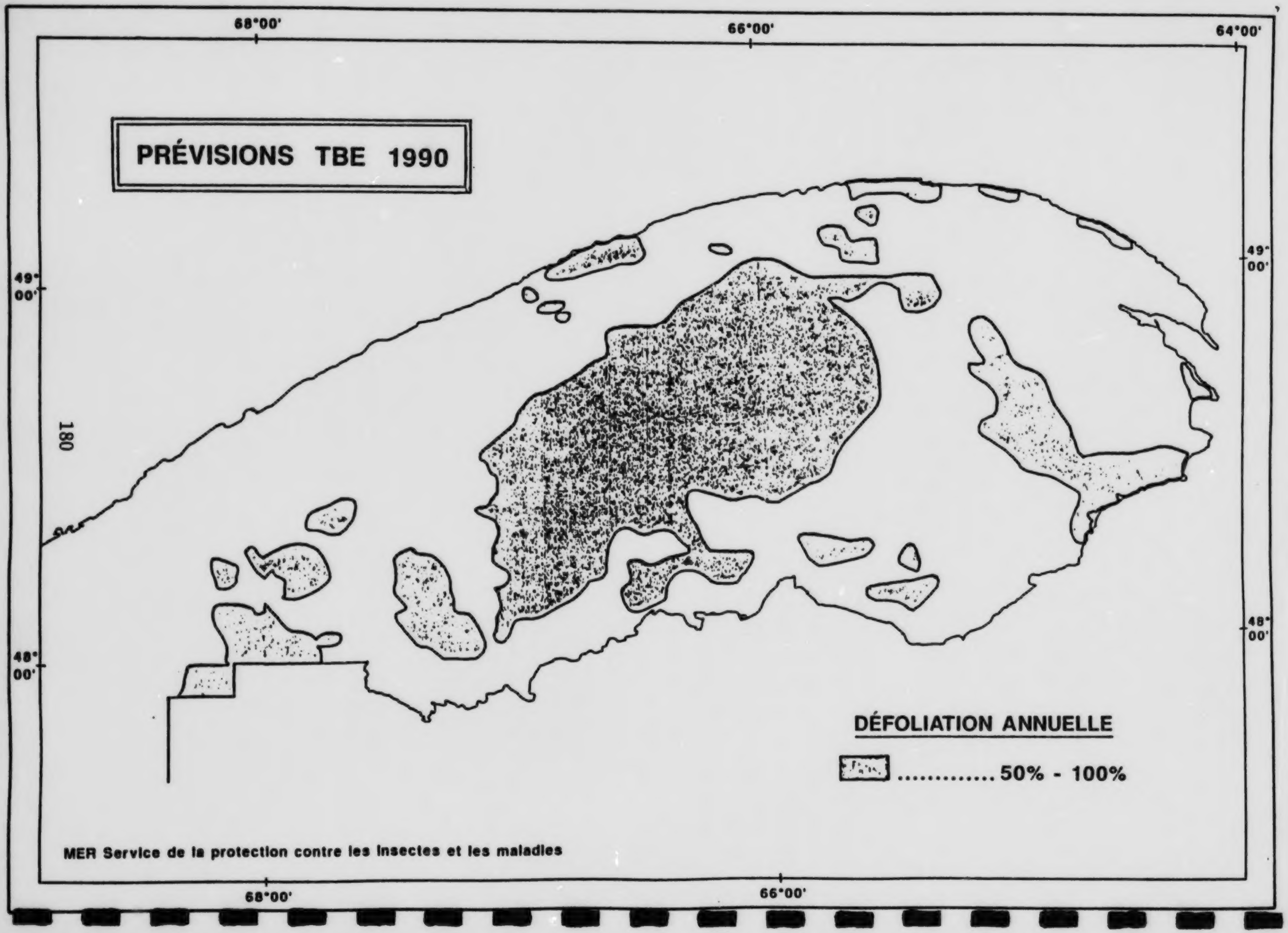
The results of the survey of overwintering spruce budworm larvae show that there will be a definite reduction in the budworm infestation in the Gaspé Peninsula next year. The 1200 samples taken in this region reveal a definite drop in the populations found throughout the area to the west of the Matapédia Valley and indicate that only a few centres persist on the Peninsula (Fig. 9).

In the Bas-Saint-Laurent -- Gaspésie region, where almost half the infested stands were treated, the budworm infestation in 1991 will be reduced by 85% over its 1990 level, while major damage is predicted over an area of 0.2 million hectares, compared to 1.3 million in 1990.

In the Côte-Nord region, the budworm infestation should not extend beyond existing centres and should cover an area of about 150 000 hectares.

In the other regions, the budworm infestation should remain at a very low level. No damage is predicted. On the other hand, monitoring of the spruce budworm population has been intensified in the western part of the province (south of Maniwaki, to be exact), as the insect has been observed there in significant numbers for the second year in a row.

FIG. 9 : INFESTATION DE LA TORDEUSE DES BOURGEONS DE L'EPINETTE PREVUE EN 1991.


68°00'
66°00'
64°00'
49° 00'
48° 00'
PRÉVISIONS TBE 1990
DÉFOLIATION ANNUELLE
▨ ....50% - 100%
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SPRUCE BUDWORM IN ONTARIO, 1990[1]

- Outbreak Status, 1990
- Forecasts, 1991
- Results of Spraying Operations, 1990

by

G.M. Howse[2], J.H. Meating[2] and J.J. Churcher[3]

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[1] Report prepared for the Eighteenth Annual Forest Pest Control Forum, Ottawa, November 20-21, 1990.

[2] Forestry Canada, Ontario Region, Great Lakes Forestry Centre, Sault Ste. Marie.

[3] Ontario Ministry of Natural Resources, Forest Health and Protection Section, Sault Ste. Marie.

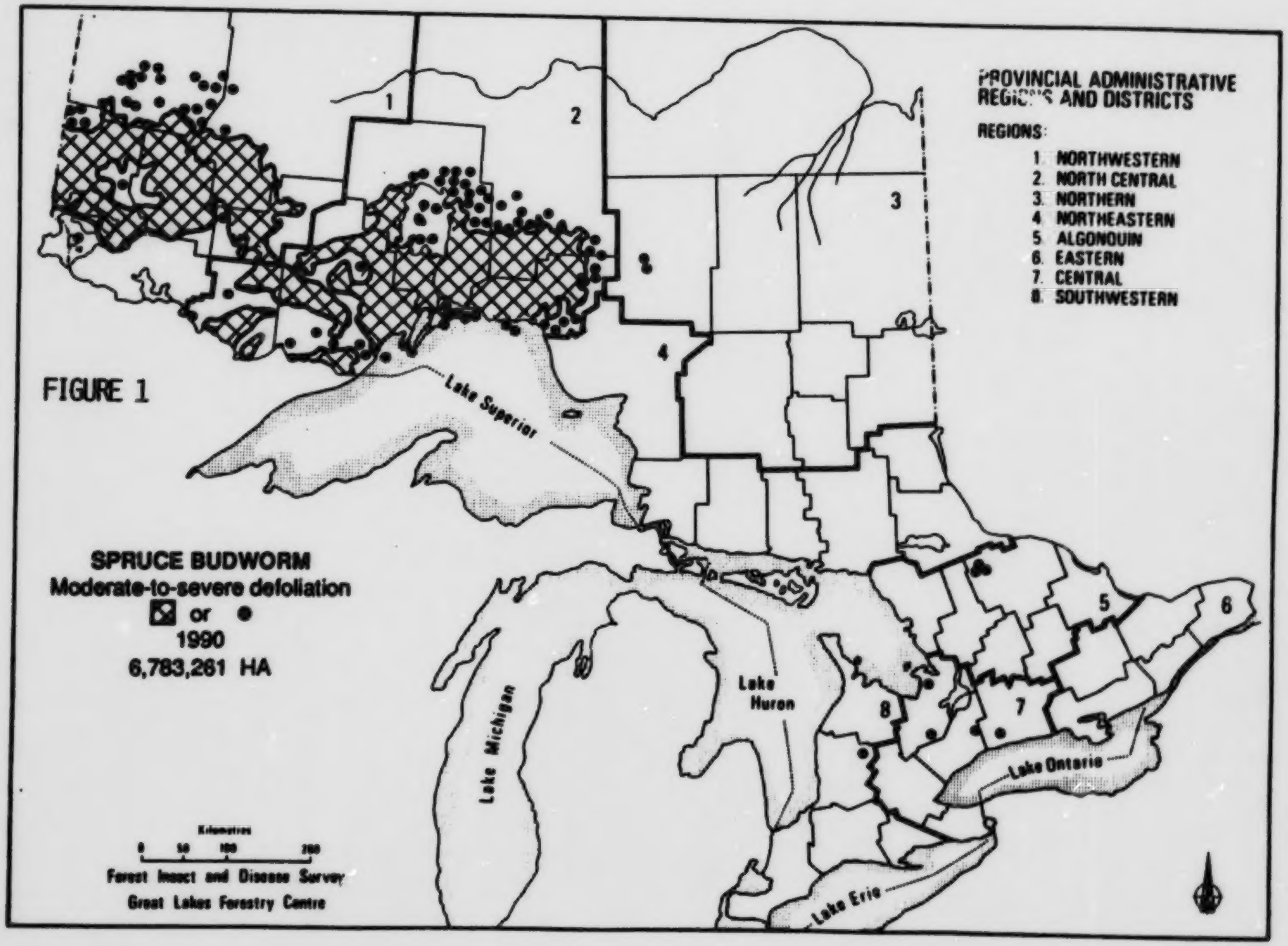
OUTBREAK STATUS 1989

The area infested by spruce budworm in Ontario increased in 1990 for the second consecutive year. Province-wide, a total of 6,783,261 ha of moderate-to-severe defoliation were mapped by aerial and ground surveys (Fig. 1). This represents an increase of 543,625 ha over the 6,239,636 ha recorded last year (Table 1). It should be pointed out that these figures represent gross areas within which defoliation occurred. Most of the defoliation again occurred in the Northwestern and North Central regions but new areas of 6,392 ha were mapped in the Hearst District of the Northern Region, 2,815 ha in the Algonquin Park District, Algonquin Region and single small plantations in the Central and Southwestern regions sustained moderate-to-severe defoliation.

In the Northwestern Region, the overall area affected declined by about 457,000 ha. In this region, slight increases which occurred along the northern periphery of the infestation, mainly in the Red Lake District were offset by moderate decreases in Ignace, Dryden, Kenora and Sioux Lookout districts and a major decline in the area affected in the Fort Frances District. In the North Central Region, a moderate decrease in the Atikokan District was accompanied by large increases in the area affected in Thunder Bay, Nipigon, Geraldton and Terrace Bay districts. The main outbreak is again composed of two very large infestations with numerous small pockets along the northern edge and a few along the southern edge. The first large infestation stretches from the Manitoba border eastward through parts of the Kenora, Fort Frances, Dryden, Red Lake, Sioux Lookout, Ignace and Atikokan districts to the Shabaqua-Raith area of the southwestern Thunder Bay District encompassing an area of approximately 3,079,700 ha. It is separated by a narrow budworm-free corridor from the second infestation which covered approximately 3,093,000 ha from the Graham-Thunder Bay area of Thunder Bay District through the Nipigon District to the Manitouwadge-Stevens area in the Terrace Bay and Geraldton districts. This infestation included most of the islands in Lake Nipigon as well as most of the islands along the northwest coast of Lake Superior. Three sizeable infestations were mapped along the American border in the Atikokan and Thunder Bay districts. These were located in the Lac la Croix-Pickerel Lake-Argo Lake area (186,779 ha) in Bayley Bay-Agnes Lake area (44,083 ha), and in the Gunflint Lake-Silver Mountain-Horne Falls area (88,083 ha).

The infestation in Hearst District occurred around the west end of Nagagamisis Lake including parts of Frost and McEwing townships and the west end of Nagagamisis Provincial Park. New infestations in southern Ontario included a total of 2,815 ha of defoliation mapped in Biggar and Devine townships, Algonquin Park District, an 18-ha white spruce plantation in Wingham District, a 7-ha white spruce plantation in Huronia District and a 5-ha white spruce plantation in Maple District. Aerial mapping of spruce budworm-caused tree mortality showed a total area of 3,098,189 ha within which balsam fir and white spruce has died (Fig. 2), an increase of some 1,214,473 ha over 1989.

FIGURE 1

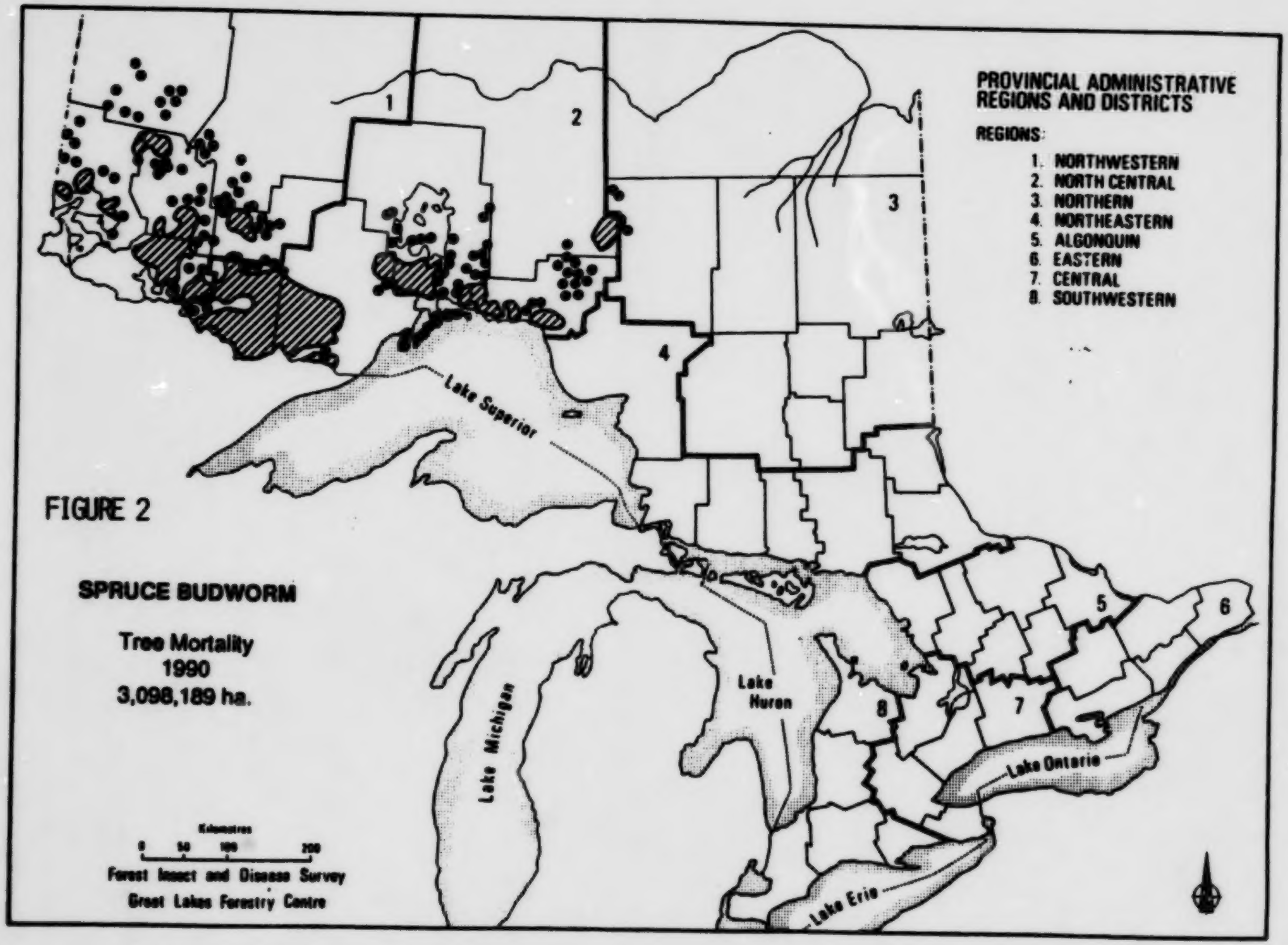


SPRUCE BUDWORM
Moderate-to-severe defoliation
▨ or ●
1990
6,783,261 HA

PROVINCIAL ADMINISTRATIVE
REGIONS AND DISTRICTS
REGIONS:
1. NORTHWESTERN
2. NORTH CENTRAL
3. NORTHERN
4. NORTHEASTERN
5. ALGONQUIN
6. EASTERN
7. CENTRAL
8. SOUTHWESTERN
1
2
3
4
5
6
7
8
Lake Superior
Lake Michigan
Lake Huron
Lake Ontario
Lake Erie
Kilometres
0
50
100
200
Forest Insect and Disease Survey
Great Lakes Forestry Centre

Table 1. Gross area (ha) of current moderate-to-severe defoliation by spruce budworm in Ontario from 1988 to 1990.

Region	Area of moderate-to-severe defoliation (ha)			
District	1987	1988	1989	1990
Northwestern				
Ignace	584,322	512,961	419,620	314,071
Dryden	835,308	907,685	902,750	815,547
Sioux Lookout	556,457	540,334	586,772	523,344
Fort Frances	497,579	275,817	199,084	6,720
Kenora	821,074	886,627	897,779	859,395
Red Lake	256,167	266,361	199,054	228,747
	3,550,907	3,389,785	3,205,059	2,747,824
North Central				
Atikokan	808,508	578,464	482,208	410,377
Thunder Bay	1,101,963	376,395	597,382	1,273,723
Nipigon	987,526	605,741	940,513	1,087,868
Terrace Bay	528,555	260,393	624,724	761,251
Geraldton	211,954	13,956	389,750	493,011
	3,638,506	1,834,949	3,034,577	4,026,230
Northern				
Hearst	0	0	0	6,392
	0	0	0	6,392
Northeastern	0	0	0	0
Algonquin				
Algonquin Park	0	0	0	2,815
Bracebridge	350	0	0	0
	350	0	0	2,815
Total	7,189,763	5,224,734	6,239,636	6,783,261



PROVINCIAL ADMINISTRATIVE REGIONS AND DISTRICTS
REGIONS:
1. NORTHWESTERN
2. NORTH CENTRAL
3. NORTHERN
4. NORTHEASTERN
5. ALGONQUIN
6. EASTERN
7. CENTRAL
8. SOUTHWESTERN
1
2
3
4
5
6
7
8
Lake Superior
Lake Michigan
Lake Huron
Lake Ontario
Lake Erie
Kilometres
0
50
100
200
Forest Insect and Disease Survey
Great Lakes Forestry Centre

FIGURE 2

SPRUCE BUDWORM

Tree Mortality
1990
3,098,189 ha.

All of this mortality is located in the Northwestern and North Central regions. Mortality which occurred in northeastern and southern Ontario earlier during the current outbreak (1972-1984) will no longer be included in the area figures or depicted on maps. The largest increases (1,048,860 ha) occurred in the North Central Region in Atikokan, Thunder Bay and Nipigon districts. Large areas of tree mortality are also present in the southern Terrace Bay District.

FORECASTS 1991

The annual spruce budworm egg-mass survey was carried out in August for the purpose of forecasting population trends in 1991. Some 438 locations were sampled of which 332 were sampled in both 1989 and 1990. A comparison of these shows a province-wide decline of 10% in egg-mass densities (Table 2), however, it is expected that the extent of defoliation will increase to more than 7.0 million ha in 1991.

In the Northwestern Region egg-mass densities increased by 7% overall with increases in Fort Frances (11%), Kenora (33%), Red Lake (65%) and Sioux Lookout (22%) districts and decreases in Dryden (28%) and Ignace (21%) districts. An analysis of these results indicate that infestations will probably persist throughout most of the area infested in 1990 with some slight expansion possible along the northern periphery of the outbreaks in Kenora, Red Lake and Sioux Lookout districts. There is also a possibility of an increase in the area affected in Fort Frances District and the southern Ignace District.

In the North Central Region there was an overall decline of 22% in egg-mass densities which was composed of declines of 54%, 1%, 16% and 50%, respectively in Atikokan, Geraldton, Nipigon and Terrace Bay districts and an increase of 1% in Thunder Bay District. These declines notwithstanding, egg-mass densities are still sufficiently high that moderate-to-severe defoliation will likely persist throughout most of the area infested in 1990. There may be some intensification of defoliation in the Geraldton District but little expansion, if any, is expected in the eastern part of the outbreak.

Egg-mass densities increased markedly in the Northern and Northeastern regions but widespread, heavy infestations are not expected in 1991. An exception to this trend will likely occur in the Hearst District where the infestations around Nagagamisis Lake will probably expand. There is also a possibility that small, new pockets of defoliation could be discovered in both regions in 1991. Similarly, in southern Ontario the small infestation in Algonquin Park District may increase in size and new pockets of infestation may be discovered next year.

Table 2. Comparison of spruce budworm egg-mass densities in Ontario 1989 and 1990.

OMNR Region	No. of locations sampled in 1990	No. of locations common to 1989 and 1990	Average egg-mass density per 9.29 m2– 1988	1990	% Change
Northwestern	120	111	340	366	+7
North Central	221	148	482	378	-22
Northern	46	35	7	59	+759
Northeastern	27	23	3	7	+118
Southern Ontario	24	15	32	34	+4
Overall	438	332	331	299	-10

RESULTS OF SPRAYING OPERATIONS, 1990

A total of 49,627 ha (Table 3) was aerially sprayed in 1990 in the Nipigon and Thunder Bay districts in the North Central Region. In Nipigon District, a total of 44,189 ha was treated with 28,863 ha receiving a single application and 15, 326 ha receiving two applications. In Thunder Bay District, 5,438 ha west of Kabitotikwia Lake was sprayed once. The 1990 program included commercial forest, plantations and a provincial park. All areas were treated with Dipel 176 at 30 BIU/1.8L/ha with some forest (15,326 ha) receiving a second application at the same rate. Those areas targeted for two applications had higher budworm populations based on L_2 samples than those areas scheduled for a single application. Spraying took place from June 5-25. A total of eight fixed-wing aircraft equipped with Micronairs were used in the 1990 budworm spray budworm spray program. Three standard Thrushs and five AgTrucks worked from three airstrips, Nonwatin, Cash Creek and Jellicoe.

In the North Central Region this year, temperatures were warmer than normal during the last 10 days of April but cooled off in early May. Based on temperature data from Thunder Bay airport and Cameron Falls (Ontario Hydro Generating Station) on the Nipigon River, heat accumulation was ahead of normal by eight days at the end of April but soon reverted to almost normal by May 10 and remained normal with very little variation until the end of June.

Emergence was under way on May 16 based on field observations and probably started several days earlier. This year's heat accumulation graph for Thunder Bay is presented in Figure 3 and insect development of spray time is presented in Table 4.

Fig. 3 Heat accumulation in
degree days for Thunder Bay,Ontario 1990

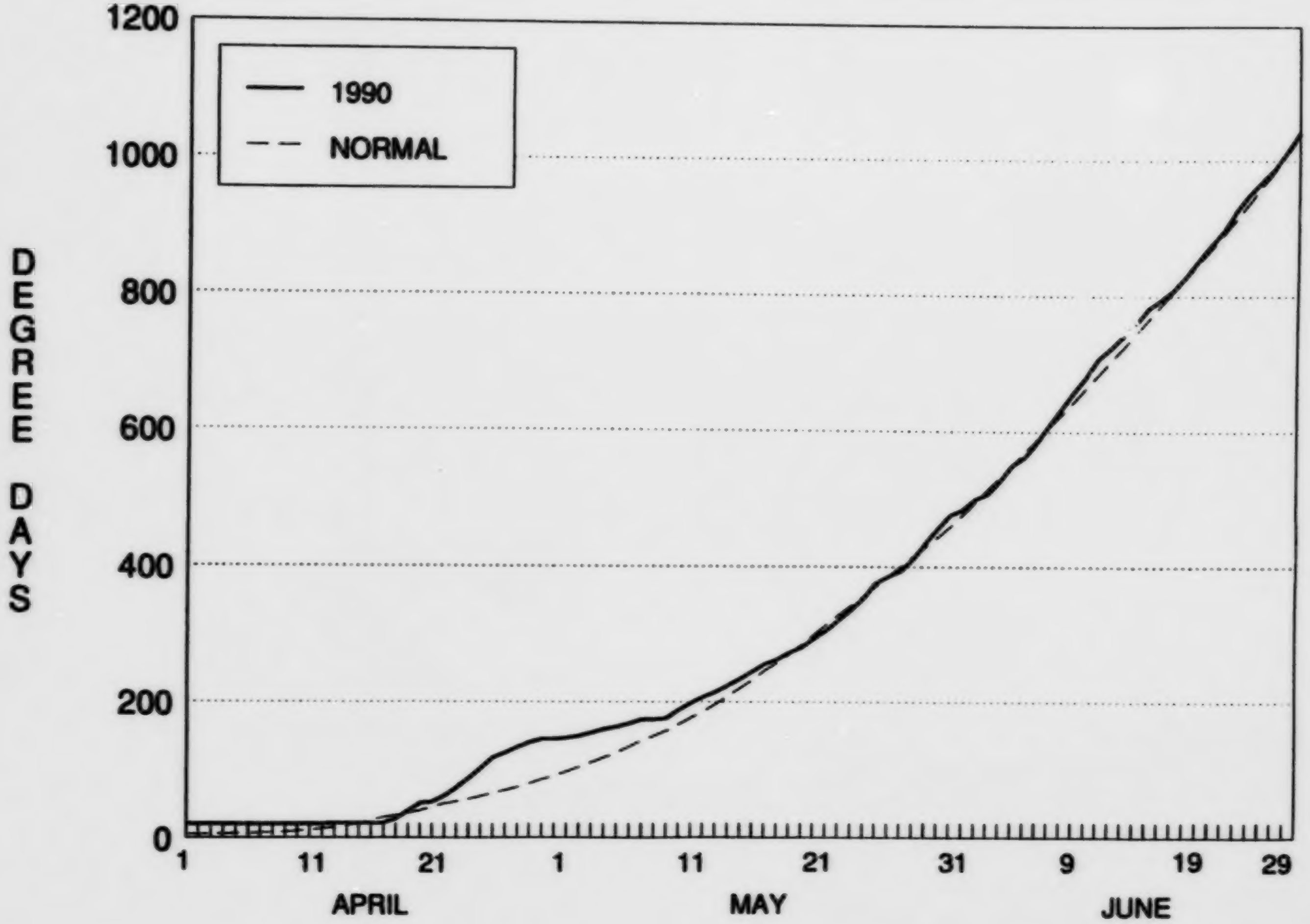


FIGURE 3

Table 3. Area sprayed in Nipigon and Thunder Bay districts in 1990

District/No. of applications	Area (ha)
Nipigon	
one application	28,863
two applications	15,326
	44,189
Thunder Bay	
one application	5,438
Total	49,627

Insect development was more or less equivalent throughout the project area by early June. The first blocks opened for spraying were blocks 85 (Shillabeer Lake) and 91 (Black Sturgeon Lake) on June 4 when insect development was primarily third instar with some fourths. In some locations, fifth and sixth instar larvae were sprayed and some blocks were not sprayed due to delays caused by weather and advanced insect development.

Approximately 197 plots (109 balsam fir and 88 white spruce) consisting of 5 to 20 trees per plot for a total of 1,355 trees (755 balsam fir and 600 white spruce) were sampled to assess the effectiveness of this year's program. In spray blocks, 495 balsam fir (340 - 1 application, 155 - 2 applications) and 370 white spruce trees (310 - 1x, 60 - 2x) were sampled whereas 260 balsam and 230 white spruce trees were sampled in untreated check plots.

Results in terms of population reduction and foliage protection due to the treatment are presented by spray blocks in Tables 5, 7 and 9 for Thunder Bay District, one application Nipigon District and two applications Nipigon District, respectively. Population reduction and foliage protection on an individual plot basis are presented in Tables 6, 8 and 10 for Thunder Bay District and for single and double applications in Nipigon District. Results are summarized for a single application compared to a double application in Table 11.

Results this year were quite variable ranging from nil to good on a block-to-block basis which is consistent with past results. Overall, this year's results, which could be characterized as fair-(minus) were the poorest of the past 8 years (since 1983). The worst previous results occurred in 1985 and 1988. By far, the results for

Table 4. Spruce budworm larval development at spray locations in Thunder Bay and Nipigon districts, 1990.

Location	Tree species	Date (June)	Stage (%)					Date sprayed
			II	III	IV	V	VI	
Thunder Bay District								
Kabitotikwia Lake (Block 96)	bF	10	0	4	94	2	0	June 16
	bF	18	0	0	22	44	34	
	wS	10	0	0	34	66	0	
	wS	18	0	0	6	18	76	
Nipigon District								
Purdom and McIvor Twps (Blocks 2, 7, 8, 86)	wS	8	0	4	80	16	0	June 9-11
	wS	15	0	4	32	64	0	
Limestone Lake (Block 9)	wS	18	0	0	8	54	38	June 18
Blocks 26, 63	bF	10	0	42	58	0	0	June 10-16
	bF	19	0	0	36	54	10	
Legault Twp (Blocks 68, 69)	bF	8	0	44	56	0	0	June 9-10
	bF	12	0	0	60	40	0	
	wS	8	0	50	46	4	0	
	wS	12	0	6	38	56	0	

(cont'd)

Table 4. Spruce budworm larval development at spray locations in Thunder Bay and Nipigon districts, 1990 (concl.)

Location	Tree species	Date (June)	Stage (%)					Date sprayed
			II	III	IV	V	VI	
Nipigon District (cont'd)								
Irvin Twp and Northwind Lake	bF	8	0	16	84	0	0	June 14-19
	bF	19	0	0	16	48	36	
Sandra Twp (Blocks 77, 78)	wS	8	0	12	88	0	0	June 16
	wS	19	0	0	4	40	56	
Black Bay Peninsula (102, 103, 104, 105, 106)	bF	8	0	14	84	2	0	June 14-19
	bF	20	0	0	6	56	38	June 2-4
Black Sturgeon Lake and Shillabeer Lake (Blocks 91, 85)	bF	5	0	34	66	0	0	June 5
	bF	8	0	14	80	6	0	
	wS	5	0	6	70	24	0	
	wS	8	0	2	60	38	0	

Table 5. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for the one spray block assessed in Thunder Bay District, North Central Region, Ontario, 1990

Location	Spray date	Host	No. of plots	Prespray larvae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Kabitotikwia Lake						
Block 96	June 16	bF	3	16.8	46	63
Checks		bF		17.8		92
Block 96	June 16	wS	3	37.6	56	77
Checks		wS		36.6		90

Table 6. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Thunder Bay District, North Central Region, Ontario, 1990

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Kabitotikwia Lake Block 96					
Plot 1	bF	20.2	2.1	69	58
Checks	bF	20.6	6.8		92
Plot 2	bF	15.9	3.4	17	66
Checks	bF	16.4	4.2		92
Plot 5	bF	14.3	2.3	36	64
Checks	bF	16.4	4.2		92
Plot 2	wS	45.6	.7	0	92
Checks	wS	43.8	.6		93
Plot 3	wS	46.5	.6	0	55
Checks	wS	43.8	.6		93
Plot 5	wS	20.8	1.8	64	85
Checks	wS	22.1	5.3		83

Table 7. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray block assessed in Nipigon District, North Central Region, Ontario, 1990

Location	Spray date	Host	No. of plots	Prespray larvae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Purdom Twp						
Block 2	June 11	bF	4	52.6	15	80
Checks		bF		49.9		90
Block 2		vS	4	89.5	66	87
Checks		vS		89.7		92
Ledger Twp						
Block 7	June 10	bF	3	20.0	62	75
Checks		bF		19.5		84
Block 7		vS	3	98.3	52	74
Checks		vS		98.0		92
Limestone Lake						
Block 9	June 18	vS	4	41.1	0	83
Checks		vS		44.4		86
Block 10		vS	3	27.7	6	33
Checks		vS		24.3		58
Barbara Lake						
Block 26	June 16	bF	4	32.1	88	86
Checks		bF		32.0		89

(cont'd)

Table 7. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray block assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Spray date	Host	No. of plots	Prespray larvae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Barbara Lake (cont'd)						
Block 26		vS	4	112.8	54	91
Checks		vS		97.7		90
Block 63	June 10	bF	2	43.6	0	94
Checks		bF		42.1		91
Block 63		vS	1	70.4	0	95
Checks		vS		76.3		92
Legault Twp						
Block 68	June 9	bF	5	37.5	0	90
Checks		bF		36.8		93
Block 69	June 10	bF	3	29.4	0	77
Checks		bF		28.0		94
Sandra Twp						
Block 77	June 16	vS	2	66.4	0	70
Checks		vS		70.2		90
Meader Twp						
Block 78	June 16	vS	2	66.1	0	74
Checks						
vS			65.9		88	

(cont'd)

Table 7. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray block assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Spray date	Host	No. of plots	Prespray larvae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Northwind Lake						
Block 79	June 15	bF	2	35.4	7	81
Checks		bF		34.2		86
Block 79		vS	2	68.0	0	84
Checks		vS		70.2		90
Block 80	June 15	bF	4	38.6	68	66
Checks		bF		37.4		90
Block 80		vS	4	67.7	29	73
Checks		vS		66.7		89
Block 81	June 19	bF	4	42.3	57	85
Checks		bF		40.1		89
Block 81		vS	3	78.1	42	61
Checks		vS		74.3		94
Kilkenny Twp						
Block 84 (LNPP)	June 18	bF	4	35.0	98	64
Checks		bF		34.2		90
Block 84		vS	4	63.6	89	72
Checks		vS		65.2		90

(cont'd)

Table 7. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray block assessed in Nipigon District, North Central Region, Ontario, 1990 (concl.)

Location	Spray date	Host	No. of plots	Prespray larvae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Cockeram Twp						
Block 85	June 5	bF	7	45.0	49	69
Checks		bF		41.5		90
Block 85		vS	7	72.5	87	75
Checks		vS		72.1		91
Black Sturgeon Lake						
Block 91	June 7	bF	3	28.5	88	36
Checks		bF		27.2		89
Block 91		vS	3	74.0	77	67
Checks		vS		75.2		89
Black Bay Peninsula						
Block 106	June 15-16	bF	2	32.3	26	84
Checks		bF		30.7		92
Block 106		vS	2	91.7	64	81
Checks		vS		94.8		92

Table 8. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Purdom Twp					
Block 2					
P1	bF	35.0	2.2	61	94
Checks	bF	32.9	5.3		94
P2	bF	54.2	3.8	8	74
Checks	bF	51.3	3.9		88
P3	bF	71.8	5.4	0	68
Checks	bF	64.0	2.2		90
P4	bF	49.2	2.2	41	82
Checks	bF	51.3	3.9		88
P1	wS	103.4	.6	25	95
Checks	wS	102.7	.8		94
P2	wS	90.2	0	100	91
Checks	wS	93.8	3.4		92
P3	wS	87.2	1.6	0	78
Checks	wS	85.9	.6		90
P4	wS	77.2	0	100	85
Checks	wS	76.3	1.7		92
Ledger Twp					
Block 7					
P1	bF	29.4	1.0	82	65
Checks	bF	27.7	5.2		79
P2	bF	8.6	0.4	80	90
Checks	bF	8.2	1.9		95
P3	bF	22.0	2.4	11	69
Checks	bF	22.7	2.8		79
P1	wS	81.2	.4	33	87
Checks	wS	85.9	.6		90

(cont'd)

Table 8. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Ledger Twp (cont'd)					
Block 7					
P2	wS	88.4	.2	69	88
Checks	wS	85.9	.6		90
P3	wS	125.2	.2	50	48
Checks	wS	122.2	.4		95
Limestone Lake					
Block 9					
P1	wS	62.8	8.0	0	86
Checks	wS	63.6	2.8		93
P2	wS	31.3	9.8	0	72
Checks	wS	35.0	2.1		80
P3	wS	40.2	7.5	0	81
Checks	wS	43.8	.6		93
P4	wS	30.0	3.0	0	92
Checks	wS	35.0	2.1		80
Block 10					
P2	wS	13.7	5.0	0	21
Checks	wS	15.9	.8		12
P3	wS	19.9	2.3	52	29
Checks	wS	22.1	5.3		83
P4	wS	34.4	1.3	38	49
Checks	wS	35.0	2.1		80
Barbara Lake					
Block 26					
P1	bF	28.6	1.4	74	87
Checks	bF	27.7	5.2		79
P2	bF	42.2	.2	96	95
Checks	bF	40.7	5.6		93

(cont'd)

Table 8. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Barbara Lake (cont'd)					
Block 26					
P3	bF	52.8	.4	90	69
Checks	bF	51.3	3.9		88
P4	bF	4.8	0	100	95
Checks	bF	8.2	1.9		95
P1	wS	87.0	.4	38	90
Checks	wS	85.9	.6		90
P2	wS	179.4	0	100	95
Checks	wS	135.0	1.0		94
P3	wS	145.0	1.6	0	87
Checks	wS	135.0	1.0		94
P4	wS	39.8	.6	75	93
Checks	wS	35.0	2.1		80
Block 63					
P1	bF	33.7	8.0	0	93
Checks	bF	32.9	5.3		94
P2	bF	53.6	3.6	12	95
Checks	bF	51.3	3.9		88
P1	wS	70.4	1.6	0	95
Checks	wS	76.3	1.7		92
Legault Twp					
Block 68					
P1	bF	39.2	17.0	0	94
Checks	bF	40.7	5.6		95
P2	bF	54.3	3.5	15	74
Checks	bF	51.3	3.9		88
P3	bF	41.8	7.2	0	95
Checks	bF	40.7	5.6		93

(cont'd)

Table 8. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Legault Twp (cont'd)					
Block 68					
P4	bF	33.4	13.0	0	94
Checks	bF	32.9	5.3		94
P5	bF	18.6	4.9	6	94
Checks	bF	18.3	5.1		95
Block 69					
P1	bF	32.9	2.6	51	59
Checks	bF	32.9	5.3		94
P2	bF	19.3	9.2	0	86
Checks	bF	18.3	5.1		95
P3	bF	35.9	4.1	29	86
Checks	bF	32.9	5.3		94
Sandra Twp					
Block 77					
P1	wS	85.7	2.9	0	87
Checks	wS	85.9	.6		90
P2	wS	47.2	4.1	0	52
Checks	wS	54.5	3.4		91
Meader Twp					
Block 78					
P1	wS	66.0	1.7	0	77
Checks	wS	65.9	1.7		88
P2	wS	66.2	4.3	0	70
Checks	wS	65.9	1.7		88
Northwind Lake					
Block 79					
P1	bF	25.2	9.0	0	92
Checks	bF	27.7	5.2		79

(cont'd)

Table 8. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Northwind Lake (cont'd)					
Block 79					
P2	bF	45.7	1.4	78	70
Checks	bF	40.7	5.6		93
P1	wS	50.8	2.4	23	92
Checks	wS	54.5	3.4		91
P2	wS	85.2	3.0	0	77
Checks	wS	85.9	.6		90
Block 80					
P1	bF	44.1	1.4	77	53
Checks	bF	40.7	5.6		93
P2	bF	27.0	2.4	53	87
Checks	bF	27.7	5.2		79
P3	bF	37.8	1.6	69	65
Checks	bF	40.7	5.6		93
P4	bF	45.5	1.8	77	58
Checks	bF	40.7	5.6		93
P1	wS	32.2	.8	58	75
Checks	wS	35.0	2.1		80
P2	wS	125.0	.4	0	85
Checks	wS	122.2	.4		95
P3	wS	67.6	.6	67	71
Checks	wS	65.9	1.7		88
P4	wS	46.1	1.6	0	62
Checks	wS	43.8	.6		93
Block 81					
P1	bF	66.4	2.0	12	78
Checks	bF	64.0	2.2		90
P2	bF	43.8	.2	97	84
Checks	bF	40.7	5.6		93

(cont'd)

Table 8. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Northwind Lake (cont'd)					
Block 81					
P3	bF	35.6	3.0	47	87
Checks	bF	32.9	5.3		94
P4	bF	23.5	2.1	28	92
Checks	bF	22.7	2.8		79
P1	wS	66.6	1.8	38	63
Checks	wS	63.6	2.8		93
P2	wS	60.6	1.0	83	42
Checks	wS	57.0	5.6		95
P3	wS	107.1	3.0	0	77
Checks	wS	102.7	.8		94
Kilkenny Twp					
Block 84 (LNPP)					
P1	bF	32.0	0	100	37
Checks	bF	32.9	5.3		94
P2	bF	44.0	.4	93	77
Checks	bF	40.7	5.6		93
P3	bF	39.4	0	100	50
Checks	bF	40.7	5.6		93
P4	bF	24.5	0	100	90
Checks	bF	22.7	2.8		79
P1	wS	61.8	.2	93	62
Checks	wS	63.6	2.8		93
P2	wS	62.4	.2	93	68
Checks	wS	63.6	2.8		93

(cont'd)

Table 8. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Kilkenny Twp (cont'd)					
Block 84 (LNPP)					
P3	wS	32.2	0	100	82
Checks	wS	35.0	2.1		80
P4	wS	97.8	.6	62	77
Checks	wS	98.6	1.6		94
Cockeram Twp					
Block 85					
P1	bF	84.6	3.2	0	77
Checks	bF	64.0	2.2		90
P2	bF	35.0	3.2	43	60
Checks	bF	32.9	5.3		94
P3	bF	49.2	4.0	0	72
Checks	bF	51.3	3.9		88
P4	bF	39.6	1.0	81	94
Checks	bF	40.7	5.6		93
P5	bF	27.6	1.2	77	66
Checks	bF	27.7	5.2		79
P6	bF	34.8	1.0	82	55
Checks	bF	32.9	5.3		94
P7	bF	44.0	4.4	27	62
Checks	bF	40.7	5.6		93
P1	wS	47.2	.2	71	90
Checks	wS	43.8	.6		93
P2	wS	92.4	.4	88	62
Checks	wS	93.8	3.4		92
P3	wS	68.8	1.4	22	83
Checks	wS	65.9	1.7		88

(cont'd)

Table 8. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Cockeram Twp (cont'd)					
Block 85					
P4	wS	76.2	0	100	70
Checks	wS	76.3	1.7		92
P5	wS	75.4	0	100	79
Checks	wS	76.3	1.7		92
P6	wS	50.4	.4	87	50
Checks	wS	54.5	3.4		91
P7	wS	97.2	0	100	92
Checks	wS	93.8	3.4		92
Black Sturgeon Lake					
Block 91					
P1	bF	19.1	.6	89	49
Checks	bF	18.3	5.1		95
P2	bF	21.4	.3	88	14
Checks	bF	22.7	2.8		79
P3	bF	45.1	.3	87	45
Checks	bF	40.7	.8		93
P1	wS	67.5	.9	50	74
Checks	wS	65.9	1.7		88
P2	wS	62.1	.5	69	53
Checks	wS	65.9	1.7		88
P3	wS	92.4	0	100	73
Checks	wS	93.8	3.4		92
Black Bay Peninsula					
Block 106					
P1	bF	54.7	2.4	43	80
Checks	bF	51.3	3.9		88

(cont'd)

Table 9. Spruce Budworm: Population reduction and foliage protection attributable to two aerial applications of Dipel 176 at 30 BIU/1.8L/ha for each spray block assessed in Nipigon District, North Central Region, Ontario, 1990.

Location	Spray dates	Host	No. of plots	Prespray larvae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Irwin Twp						
Block 72	June 14	bF	2	81.4	27	83
Checks	and 19	bF		64.0		90
Block 72		wS	1	111.2	0	85
Checks		wS		111.7		85
Block 73	June 14	bF	2	68.8	44	60
Checks	and 19	bF		57.6		89
Block 74	June 14	bF	3	63.8	42	56
Checks	and 19	bF		56.2		91
Block 74		wS	2	86.9	92	66
Checks		wS		85.0		92
Block 75	June 14	bF	3	63.2	33	65
Checks	and 19	bF		59.8		89
Block 75		wS	1	69.8	100	69
Checks		wS		74.6		93
McIvor Twp						
Block 86	June 9	bF	5	54.5	69	37
Checks	and 21	bF		48.5		92

(cont'd)

Table 8. Spruce Budworm: Population reduction and foliage protection attributable to a single aerial application of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (concl.)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Black Bay Peninsula (cont'd)					
Block 106					
P2	bF	9.9	2.2	0	89
Checks	bF	10.1	2.0		95
P1	vS	133.4	1.2	0	76
Checks	vS	135.0	1.0		94
P2	vS	50.0	.3	90	86
Checks	vS	54.5	3.4		91

Table 9. Spruce Budworm: Population reduction and foliage protection attributable to two aerial applications of Dipel 176 at 30 BIU/1.8L/ha for each spray block assessed in Nipigon District, North Central Region, Ontario, 1990 (concl.)

Location	Spray dates	Host	No. of plots	Prespray larvae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
McIvor Twp (cont'd)						
Block 86		vS	1	90.1	91	37
Checks		vS		93.8		92
Black Bay Peninsula						
Block 102	June 16, 24,	bF	2	41.2	76	77
Checks	25 and 24, 25	bF		42.1		91
Block 102		vS	2	116.2	0	82
Checks		vS		114.6		90
Block 104	June 19, 24	bF	1	21.6	48	76
Checks	and 24	bF		22.7		79
Block 104		vS	1	72.2	50	74
Checks		vS		76.3		92

Table 10. Spruce Budworm: Population reduction and foliage protection attributable to two aerial applications of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Irvin Twp					
Block 72					
P1	bF	70.8	1.2	50	82
Checks	bF	64.0	2.2		90
P2	bF	91.9	2.9	7	84
Checks	bF	64.0	2.2		90
P1	wS	111.2	.8	0	85
Checks	wS	111.7	.3		85
Block 73					
P1	bF	82.4	3.8	0	83
Checks	bF	64.0	2.2		90
P2	bF	55.2	.3	93	38
Checks	bF	51.3	3.9		88
Block 74					
P1	bF	88.2	3.6	0	68
Checks	bF	64.0	2.2		90
P2	bF	66.0	2.0	9	48
Checks	bF	64.0	2.2		90
P3	bF	37.2	1.0	80	51
Checks	bF	40.7	5.6		93
P1	wS	78.0	0	100	59
Checks	wS	76.3	1.7		92
P2	wS	95.8	.4	89	72
Checks	wS	93.8	3.4		92
Block 75					
P1	bF	54.3	1.9	54	75
Checks	bF	51.3	3.9		88

(cont'd)

Table 10. Spruce Budworm: Population reduction and foliage protection attributable to two aerial applications of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (cont'd)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Irwin Twp (cont'd)					
Block 75					
P2	bF	59.4	2.4	0	57
Checks	bF	64.0	2.2		90
P3	bF	76.0	1.6	38	63
Checks	bF	64.0	2.2		90
P3	wS	69.8	0	100	69
Checks	wS	74.6	3.8		93
McIvor Twp					
Block 86					
P1	bF	34.7	1.2	79	27
Checks	bF	32.9	5.3		94
P2	bF	72.7	2.0	20	44
Checks	bF	64.0	2.2		90
P3	bF	80.4	2.4	11	35
Checks	bF	64.0	2.2		90
P4	bF	43.6	.6	90	32
Checks	bF	40.7	5.6		93
P5	bF	41.0	1.1	80	48
Checks	bF	40.7	5.6		93
P6	wS	90.1	.3	91	37
Checks	wS	93.8	3.4		92
Black Bay Peninsula					
Block 102					
P1	bF	50.3	.9	76	62
Checks	bF	51.3	3.9		88
P2	bF	32.0	1.3	75	92
Checks	bF	32.9	5.3		94

(cont'd)

Table 10. Spruce Budworm: Population reduction and foliage protection attributable to two aerial applications of Dipel 176 at 30 BIU/1.8L/ha for each spray plot assessed in Nipigon District, North Central Region, Ontario, 1990 (concl.)

Location	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
Black Bay Peninsula (cont'd)					
Block 102					
P1	wS	118.5	.8	0	74
Checks	wS	117.0	.4		90
P2	wS	113.9	.5	0	89
Checks	wS	112.2	.5		91
Block 104					
P5	bF	21.6	1.4	48	76
Checks	bF	22.7	2.8		79
P5	wS	72.2	.8	50	74
Checks	wS	76.3	1.7		92

the majority of the blocks this year could be described as fair or poor as follows: one application; Kabitotikwia Lake, Block 96 - fair, 2 - poor, 7 - poor, 26 - poor, 63 - nil, 69 - poor, 69 - poor, 79 - poor, 80 - poor, 81 - poor, 84 - fair, 85 - fair, 91 - good, 106 poor; two applications; 72 - poor, 73 - fair, 74 - fair, 75 - fair, 86 - good, 102 - poor, 104 - poor. Two applications provided better foliage protection than one application (Table 11).

Table 11. Spruce Budworm. Comparison of population reduction and foliage protection attributable to single and double aerial applications of Dipel 176 at 30 BIU/1.8L/ha in the North Central Region, Ontario, 1990

	Host	Pre larvae per 46 cm branch tip	Post pupae per 46 cm branch tip	Population reduction due to spray (%)	1990 Defoliation (%)
1 application	bF	34.9	3.0	35	75
Checks	bF	33.7	4.5		90
1 application	wS	75.5	1.3	32	77
Checks	wS	75.2	1.9		91
2 applications	bF	56.4	1.8	51	65
Checks	bF	50.1	3.3		89
2 applications	wS	91.1	.4	78	69
Checks	wS	92.7	2.0		91

Excessive rain, very high budworm populations and advanced insect development at time of treatment explain, to a considerable extent, the poor results. Based on weather records from Cameron Falls, rain occurred on 15 days during the first 21 days of June and on 14 occasions during the first 22 days at Thunder Bay airport. The total precipitation for June at Thunder Bay airport was 135.1 mm compared to a normal of about 76 mm. The total at Cameron Falls was 90.5 mm.

Delays early in spray programs caused by weather or by other factors will result in advanced insect development when treatments are finally applied. Foliage protection will suffer as a result.

Previously in this report, reference was made to certain areas being targeted for two applications based on high L_2 samples. Indeed, overall and irrespective of treatment regime, budworm populations this year were the highest of any sprayed in the North Central Region over the last five years. Pre-spray densities of spruce budworm larvae in

Thunder Bay and Nipigon districts spray programs from 1986 to 1990 are summarized by host species in Table 12.

Table 12. Spruce Budworm: Prespray larval densities in Thunder Bay and Nipigon districts, 1986-1990

Year	Prespray larvae per 46 cm branch tip	
	bF	wS
1986	9.3	20.3
1987	9.9	28.3
1988	18.0	37.0
1989	27.7	55.2
1990	42.1 (92)[1]	80.2 (179)[2]

[1] and [2], highest plot density for balsam fir and white spruce, respectively.

In conclusion, weather and high insect populations combined to produce generally fair to poor foliage protection this year, although there were exceptions with good protection achieved for some blocks. However, information from other regions and from experimental spraying trials in Ontario indicate that no or very little foliage protection was accomplished and by comparison, Ontario's operational results in 1990 are relatively good.

GYPSY MOTH IN ONTARIO, 1990[1]

Outbreak Status, 1990
Forecasts, 1991
Results of Spraying Operations, 1990

by

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[1] Report prepared for the Eighteenth Annual Forest Pest Control Forum, Ottawa, November 20-22, 1990.

[2] Forestry Canada, Ontario Region, Great Lakes Forestry Centre, Sault Ste Marie.

[3] Ontario Ministry of Natural Resources, Forest Health and Protection Section, Sault Ste Marie.

Outbreak Status, 1990

Despite the steady spread of this pest into new areas of the province, the area of moderate-to-severe defoliation declined slightly in 1990 to a total of 77,648 ha (Fig. 1, Tables 1,2 and 3) compared to a total of 81,640 ha in 1989.

Most of this decline occurred in the Eastern Region where large infestations totalling 68,981 ha in 1989 in Brockville, Tweed, Carleton Place and Napanee districts broke up into numerous small pockets totalling 5,[illegible]83 ha in 1990 (Fig.1, Table 2). Significant increases occurred in the Algonquin Region where 39,235 ha of defoliation were mapped. This was an increase of some 38,001 ha from the previous year. Moderate-to-severe defoliation was observed for the first time in Algonquin Park (172 ha), Bracebridge (4,359 ha) and Parry Sound (9,367) districts. In the Central Region, the infestation increased from 6,618 ha in 1989 to 28,624 ha in 1990. The area of infestation expanded in Niagara (19,474 ha) and Maple (2,291 ha) districts and was detected for the first time in Cambridge (3,323 ha) and Huronia (2,418 ha) districts in 1990. Most of the defoliation occurred in scattered pockets ranging in size from a few hectares to just over 1,500 ha. After several years of expansion, the outbreak in Lindsay District declined by some 2,953 ha this year to a total of 1,118 ha. In the Southwestern Region, scattered pockets of medium-to-heavy infestations were more widespread in southwestern Simcoe District than in 1989, but the total area affected decreased by 901 ha to 3,906 ha. New areas of gypsy moth defoliation totalling 50 ha were mapped in Aylmer and Chatham districts. Larvae were observed at many other locations in southern Ontario causing light and occasionally moderate defoliation.

In the Northeastern Region of the province, larvae and egg masses were detected at several locations on Manitoulin Island and the McBean Harbour Junior Ranger Camp in Espanola District, and in Killarney Provincial Park in Sudbury District.

Forecasts, 1991

Egg-mass surveys are currently being conducted by the Ministry of Natural Resources throughout southern Ontario. Results of these surveys will not be available for several weeks. However, egg-mass surveys carried out in conjunction with the 1990 spray assessment have been completed and suggest that infestations in the Eastern Region and parts of the Central Region, where the insect has been causing defoliation for a number of years, will probably continue to decline in 1991 (Table 4). In other areas, particularly in the Algonquin and Southwestern Regions, where the outbreak is relatively new, infestations are likely to expand in 1991, affecting more stands and a greater total area.

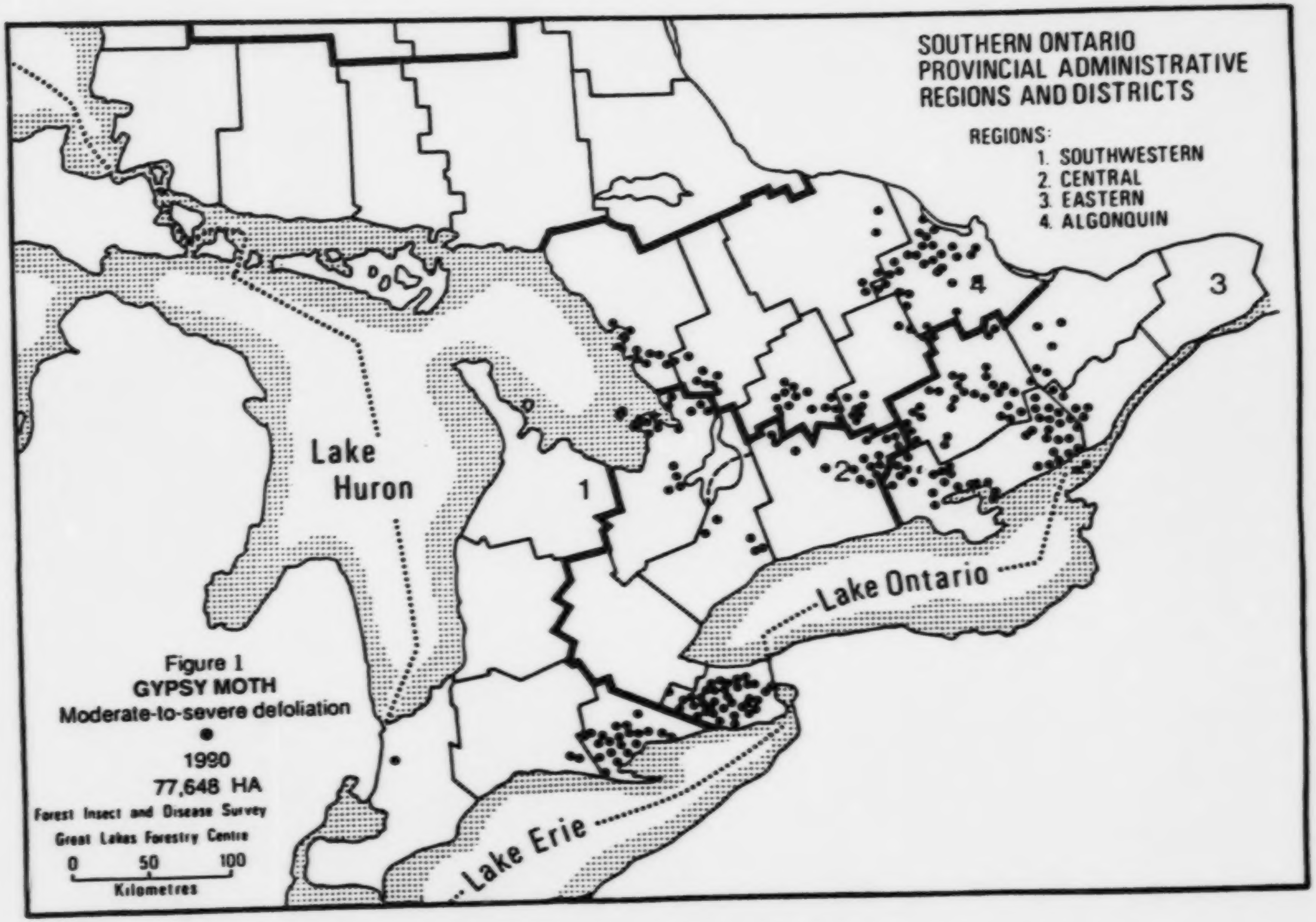
Figure 1
GYPSY MOTH
Moderate-to-severe defoliation
●
1990
77,648 HA
Forest Insect and Disease Survey
Great Lakes Forestry Centre

SOUTHERN ONTARIO
PROVINCIAL ADMINISTRATIVE
REGIONS AND DISTRICTS
REGIONS:
1. SOUTHWESTERN
2. CENTRAL
3. EASTERN
4. ALGONQUIN
1
2
3
4
Lake Huron
Lake Ontario
Lake Erie
0
50
100
Kilometres

Table 1. Gypsy moth infestations in Ontario, 1981-1990.

Year of infestation	Gross area of moderate-to-severe defoliation (ha)
1981	1,450
1982	4,800
1983	40,954
1984	80,624
1985	246,342
1986	167,776
1987	12,678
1988	29,693
1989	81,640
1990	77,648

Table 2. Gross area (ha) of moderate-to-severe defoliation by the gypsy moth in Ontario, 1986-1990.

Region	District	1986	1987	1988	1989	1990
Eastern	Tweed	73,525	3,329	16,089	39,096	1,259
	Napanee	57,780	4,781	6,198	15,001	4,086
	Carleton Place	13,386	1,355	3,918	2,634	143
	Brockville	22,283	2,099	1,865	12,250	395
		166,974	11,564	28,070	68,981	5,883
Algonquin	Algonquin Park	0	0	0	0	172
	Bracebridge	0	0	0	0	4,359
	Pembroke	221	0	124	1,154	7,148
	Bancroft	164	111	370	15	13,133
	Minden	0	0	0	65	5,056
	Parry Sound	0	0	0	0	9,367
		385	111	494	1,234	39,235
Central	Cambridge	0	0	0	0	3,323
	Huronia	0	0	0	0	2,418
	Lindsay	417	888	861	4,071	1,118
	Niagara	0	0	28	2,177	19,474
	Maple	0	0	0	370	2,291
		417	888	889	6,618	28,624
Southwestern	Aylmer	0	0	0	0	30
	Chatham	0	0	0	0	20
	Simcoe	0	115	240	4,807	3,856
		0	115	240	4,807	3,906
Total		167,776	12,678	29,693	81,640	77,648

Table 3. Gross area (ha) of moderate-to-severe defoliation by the gypsy moth, 1986-1990.

Locality	1986	1987	1988	1989	1990
Brant[a]	0	0	0	0	2,574
Durham[b]	0	118	51	50	567
Elgin[a]	0	0	0	0	30
Frontenac[a]	109,442	1,775	1,861	11,625	3,234
Haldimand-Norfolk[b]	0	115	240	4,937	12,061
Haliburton[a]	0	0	0	0	4,187
Halton[b]	0	0	0	0	397
Hamilton-Wentworth[b]	0	0	0	0	352
Hastings[a]	11,668	4,511	5,625	22,262	806
Lambton[a]	0	0	0	0	20
Lanark[a]	13,356	1,355	3,918	2,590	143
Leeds and Grenville[a]	22,283	2,099	1,865	12,250	395
Lennox and Addington[a]	8,627	407	10,007	12,660	905
Muskoka[a]	0	0	0	0	10,137
Niagara[b]	0	0	28	2,047	11,269
Nipissing[c]	0	0	0	0	172
Northumberland[a]	1,430	2,131	5,341	8,231	607
Ottawa-Carleton[b]	221	0	0	44	0
Parry Sound[c]	0	0	0	0	3,589
Peterborough[a]	179	167	565	3,045	14,554
Prince Edward[a]	540	0	0	340	74
Renfrew[a]	0	0	124	1,154	7,148
Simcoe[a]	0	0	0	0	2,418
Victoria[a]	0	0	68	35	123
York[b]	0	0	0	370	1,886
Total	167,776	12,678	29,693	81,640	77,648

[a] County

[b] Regional Municipality

[c] District

Results of Spraying Operations

In 1990, the Ontario Ministry of Natural Resources aerially treated a total of 33,956 ha of gypsy moth infested forest in eleven districts in southern Ontario. Two B.t. products, Dipel 132 and Futura XLV, were applied to 4,730 ha of crown land and 29,226 ha of private land. With the exception of a few blocks in the Ivy Lea and Westport areas in the Eastern Region, which received single applications, all blocks were treated twice (2X 30 BIU/2.01/ha). Both fixed wing (Ag Trucks, Ag Cats, Pawnees) and rotary wing (Bell 206's, Hughes 500's and A-Stars) aircraft equipped with Micronairs were used.

In early April, prior to gypsy moth egg hatch, 50 egg masses were collected from each of eight locations throughout the proposed spray area to assess overwintering survival rates. Twenty-five egg masses were collected from the ground and another 25 from the boles of trees. The egg masses were allowed to hatch in the quarantine facility at the Great Lakes Forestry Centre and the percent egg-mass hatch, average number of eggs per mass, and the average number of emerged larvae per egg mass was determined for each location (Table 5). In previous years, we have found that egg masses laid on the ground and below the snow cover generally had a much higher survival rate than those laid on the boles of the tree and thus, above the snow line (Table 6). 1990 was no different and egg-mass survival was consistently higher on the ground than on the bole. Between-site variation was considerable, but survival was highest at the most southerly location surveyed in Simcoe District where winter temperatures are somewhat more moderate than in the other locations to the north and east. A high proportion of egg masses survived on the ground and bole at Ivy Lea in Brockville District, but survival was reduced at other locations. In some cases, no eggs survived on the boles of the trees (Napanee, Tweed, and Carleton Place North) and, with the exception of Simcoe and Brockville, the proportion of eggs per mass that actually produced viable larvae was very low. Table 6 summarizes overwintering egg survival from 1983 to 1990. Average egg-mass sizes in 1990 (Ground= 232, Bole= 207) were somewhat below the previous seven year averages (Ground=284, Bole=272). The average number of viable larvae hatching from egg masses on the ground (194) in 1990 was also lower than the seven year average of 257, while egg masses on the boles of trees produced an average of 157 larvae in 1990, slightly above the seven year average of 141. One could speculate that the record low temperatures that occurred in many parts of the province during late November and December, 1989 may be responsible for this reduced survival.

Crews began monitoring gypsy moth egg hatch in late April and found that in all areas, larvae had already started to emerge from egg masses. In the Niagara, Simcoe and Chatham areas, hatch was completed by May 8 or 9. Further to the north and east in the Minden, Awenda, Tweed and Brockville areas, hatch was not complete until May 23 or 24. Weather records from throughtout the region showed that temperatures from late April to early May were well above normal with daily maximums often greater than 20°C and as high as 28°C on accasion (Fig. 2 and 3). Temperatures were generally cooler than normal during the latter part of May in all areas but returned to normal in June.

Aerial spraying operations started on May 19 in the Simcoe area and in most other areas by May 25. In all of these areas, hatch was complete and larvae were predominantly first instars (Table 7). Leaf expansion was estimated on red and white oak and, while variable, had reached 40%-60% in most locations. Spraying did not begin in the northern part of Carleton Place District until June 5 when larvae were mostly second and third instars. Second applications were completed in most areas by June 14 when larvae were mostly fourth instar, but in the Brockville area the program was not finished until June 20 when larvae were in the fourth, fifth and sixth instars.

Spray efficacy was assessed in terms of egg-mass reduction and foliage protection in sprayed versus unsprayed check plots. Results of the 1990 operations are presented in Table 8 and 9. As is often the case, this years results were highly variable and in many instances egg-mass reductions and defoliation levels were very similar in both spray and check plots. It is not unusual for gypsy moth populations to collapse naturally in areas that have been infested for two or three years. This appears to have occurred in many locations in 1990. When the results are examined in terms of infestation age, a definite pattern emerges (Tables 10 and 11). Egg-mass densities were similarly reduced in spray (-98%)and check (-93%) plots in areas that had been infested for more than two years (Table 10). In areas where the infestation was less than two years old, however, egg-mass densities were reduced by an average of 76% in the spray plots, but increased by an average of 98% in the check plots. Red and white oak defoliation rates followed a similar pattern based on age of the infestation (Table 11). Mean defoliation rates in the older infestations were essentially the same in both spray (rO=20%, wO=15%) and check (rO=20%, wO=23%) plots, but in the new infestations, defoliation rates in the check plots (rO=52%, wO=60%) were nearly twice as high as in the spray plots (rO=28%, wO=28%). Thus, in the older infestations, there appears to be very little benefit from spraying in terms of population reduction and foliage protection. In newly infested areas, however, significant reductions in egg-mass density and host defoliation were achieved.

Fig. 2 Heat accumulation in degree days for Ottawa,Ontario 1990

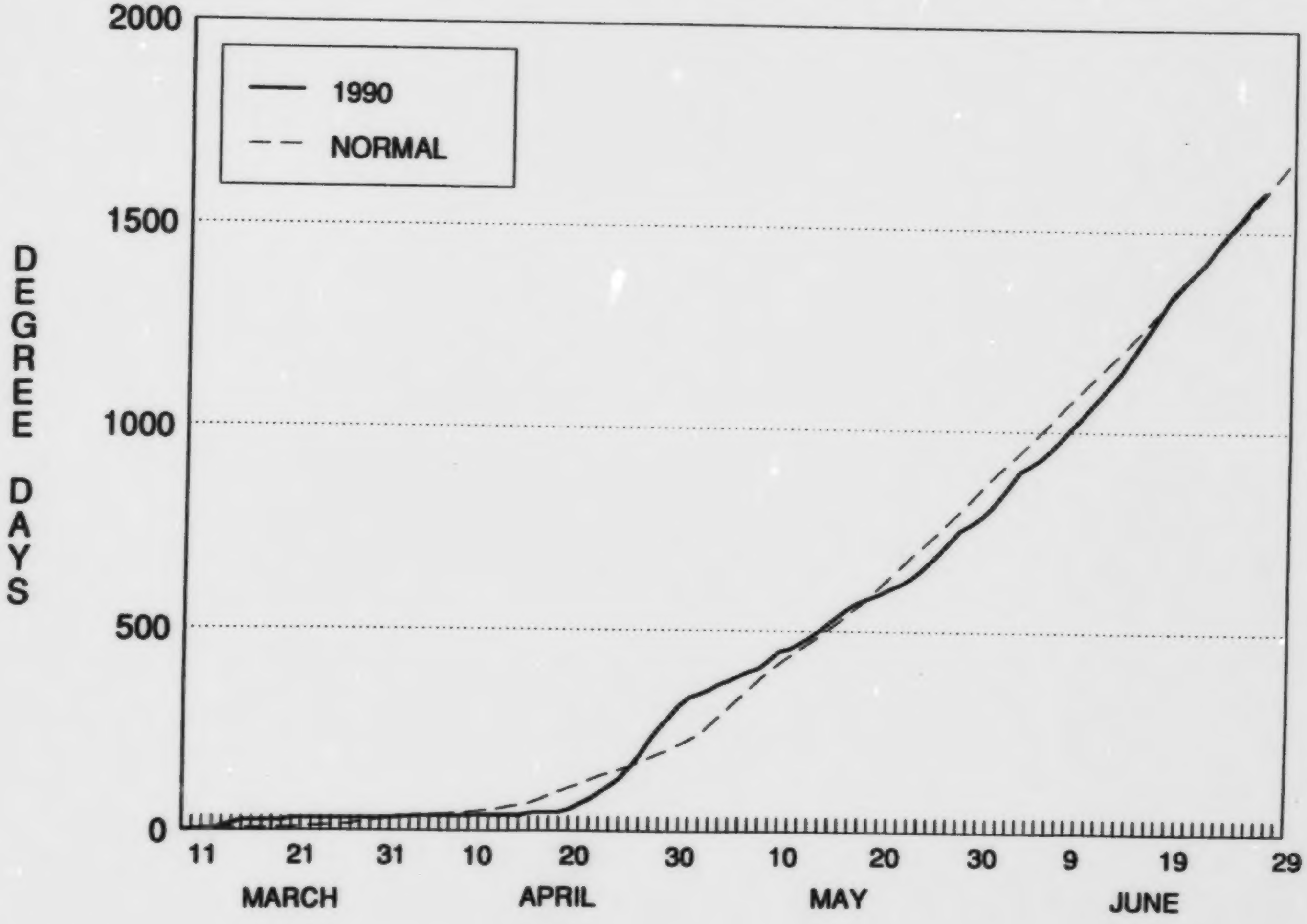

Fig. 3 Heat accumulation in degree days for Simcoe,Ontario 1990

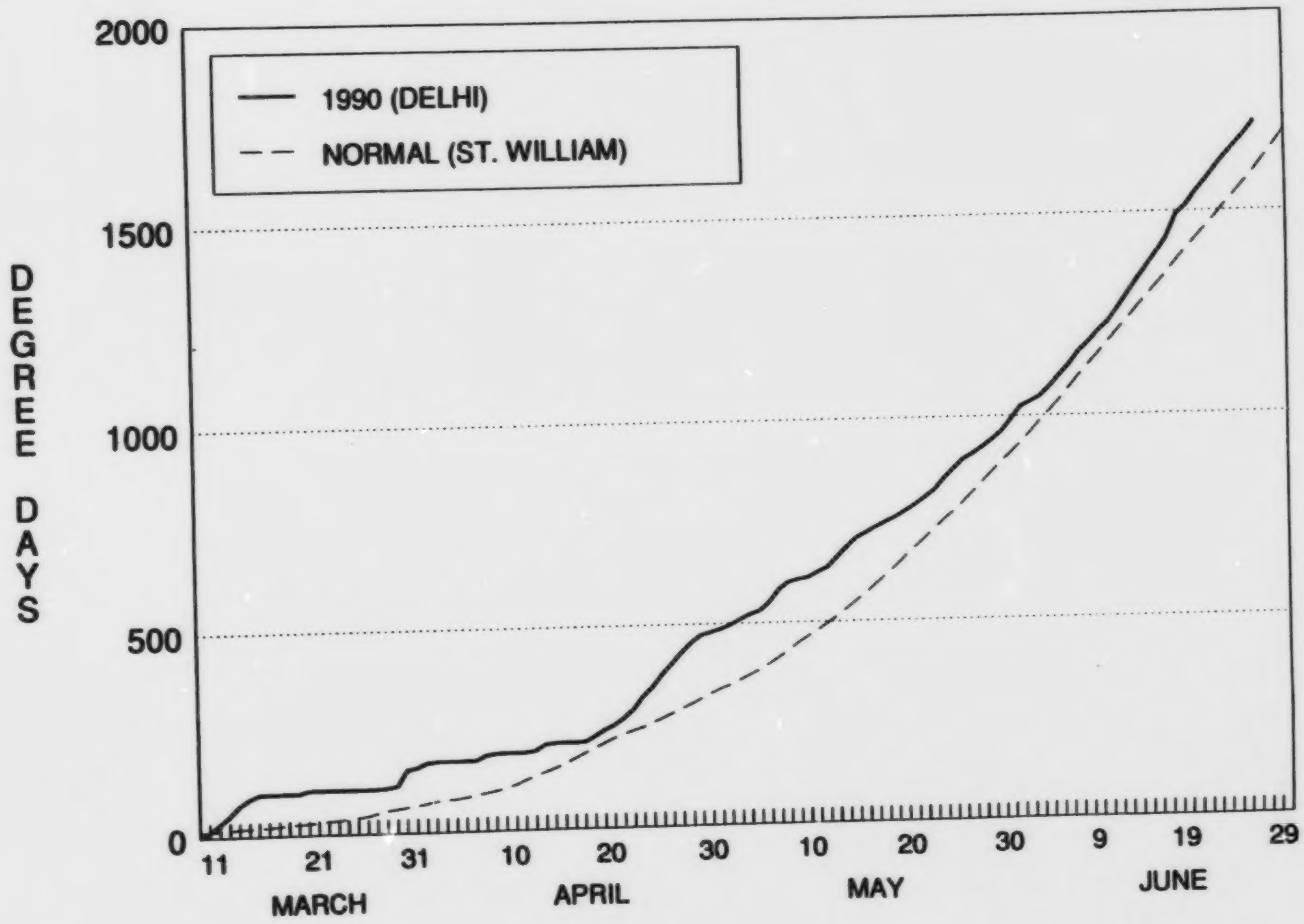

Table 4. Gypsy moth: Comparison of egg-mass densities in unsprayed plots in southern Ontario in 1989 and 1990.

District	No. of plots	Average egg masses per .01 ha 1989	Average egg masses per .01 ha 1990	% Change
Brockville	8	156	5	-97
Carleton Pl.	7	29	5	-81
Napanee	4	20	0.5	-98
Lindsay	8	74	12	-84
Maple	3	47	210	+347
Huronia	9	85	54	-36
Niagara	8	211	12	-94
Simcoe	60	51	71	+39
Cambridge	3	50	446	+792
Overall	110	71	63	-12

Table 5. Gypsy moth: Overwintwering egg-mass survival in southern Ontario, 1989-90.

District	Egg-mass hatch(%)		Eggs per mass (X)		Larvae per egg-mass(X)[c]	
	G[a]	B[b]	G	B	G	B
Simcoe	100	96	318	357	267	310
Huronia	96	4	294	204	259	0.4
Minden	96	4	290	157	284	0.3
Napanee	72	0	143	152	82	0
Tweed	38	0	174	95	67	0
Brockville	100	72	97	108	80	60
Carleton PL.S	83	16	263	323	199	22
Carleton PL.N	76	0	195	255	90	0
Overall	87	24	232	207	194	157

[a]- Ground
[b]- Bole
[c]- Calculation is based only on egg masses that produced viable larvae.

Table 6. Gypsy moth: Overwintering egg survival in southern Ontario, 1983 to 1990.

Year	Egg-mass hatch (%)		Eggs per mass (X)		Larvae per egg-mass (X)[c]	
	G[a]	B[b]	G	B	G	B
1983	100	100	285	241	274	223
1984	96	22	356	354	327	40
1985	84	45	375	276	315	125
1986	99	89	259	270	247	166
1987	98	48	217	285	207	108
1988	96	66	280	232	252	161
1989	92	77	218	247	177	165
1990	87	24	232	207	194	157

[a] = Ground

[b] = Bole

[c] = Calculation is based only on egg masses that produced viable larvae.

Table 7. Gypsy moth: Spray application dates and insect and host development at the start of 1990 spray operations

District	Start of spray	Larval Instar (%)			Leaf Expasion (%)	
		I	II	III	r0	v0
Simcoe	May 19	71	20	9	53	40
Chatham	May 22	55	39	6	39	43
Niagara	May 22	58	41	1	64	43
Huronia	May 23	98	2		51	-
Napanee	May 25	70	30		62	55
Tweed	May 23	87	13		46	48
Brockville	May 25	96	4		53	41
Carleton Place	May 25	99	1		53	-

Table 8. Gypsy moth: Egg-mass counts and current defoliation in sprayed (2 applications of *B.t.*) and unsprayed plots in southern Ontario, 1990

Location	No. of plots	Egg-masses per .01 ha		% Change	% Defoliation	
		1989	1990		r0[a]	w0[b]
Brockville District						
Charleston	5	18.4	1.8	-90	18	18
Checks	2	26.5	0	-100	13	14
Hill Island	7	19.8	2.4	-88	11	13
Checks	2	26.5	0	-100	13	14
Charleton Place District						
Darling Twp, L 15, C 9	5	42.4	0.2	-99	19	-
Checks	7	29.3	5.4	-82	19	-
Darling Twp, L 15, C11	9	76.4	0.4	-99	13	-
Checks	4	82.5	1.5	-98	17	20
Darling Twp, L 10, C 11	8	140.0	22.2	-84	14	-
Checks	4	82.5	1.5	-98	17	-
North Burgess Twp	5	20.4	0.4	-98	20	20
Checks	2	26.5	0	-100	13	14
Napanee District						
Moira River C.A.[c]	5	10.4	0.4	-96	25	16
Checks	3	3.0	0.7	-77	10	15
Goodrich C.A.	5	11.8	0	-100	16	11
Checks	3	3.0	0.7	-77	10	15
Brighton Wildlife Area	6	72.5	0.2	-99	17	15
Checks	4	82.4	1.5	-98	17	20
Crowe Bridge C.A.	5	117.8	3.4	-97	17	16
Checks	3	148.7	26.7	-82	32	31
Lemoine Pt. C.A.	9	19.7	0	-100	13	14
Checks	2	26.5	0	-100	13	14
Ferris Prov. Park	5	113.4	0	-100	18	12
Checks	3	148.7	26.7	-82	32	31

(cont'd)

Table 8. Gypsy moth: Egg-mass counts and current defoliation in sprayed (2 applications of *B.t.*) and unsprayed plots in southern Ontario, 1990 (cont'd)

Location	No. of plots	Egg-masses per .01 ha		% Change	% Defoliation	
		1989	1990		r0[a]	v0[b]
Tweed District						
Melon Lake C.A.	5	41.0	2.6	-94	40	17
Checks	7	29.3	5.4	-82	19	
Lindsay Distrct						
Alnwick Twp, L 13, C 3	5	139.8	3.0	-98	25	18
Checks	3	148.7	26.7	-82	32	31
Maple District						
Uxbridge Twp	7	40.1	4.4	-89	45	-
Checks	3	46.7	209.7	+349	66	
Huronia District						
Avenda Prov. Park	10	73.7	3.7	-95	19	-
Checks	1	40.0	149.0	+272	98	
Six Mile Prov. Park	10	241.0	118.3	-51	55	48
Checks	4	274.5	76.7	-72	89	82
Niagara District						
St. John's CA	6	8.0	0	-100	32	38
Check	1	2.0	3.0	+50	36	-
North Grimsby Twp	5	15.2	0	-100	35	40
Checks	1	16.0	0	-100	41	45
Queenston Hts.	5	21.4	0	-100	30	28
Checks	5	37.0	4.6	-88	35	46
Simcoe District						
Turkey Pt Prov. Park	10	293.8	0.4	-99	28	27
Checks	3	500.7	24.0	-95	62	77
St. Williams Crown Forest	10	210.5	0.8	-99	27	26
Checks	3	500.7	24.0	-95	62	77

(cont'd)

Table 8. Gypsy moth: Egg-mass counts and current defoliation in sprayed (2 applications of *B.t.*) and unsprayed plots in southern Ontario, 1990 (concl.)

Location	No. of plots	Egg-masses per .01 ha		% Change	% Defoliation	
		1989	1990		rO[a]	wO[b]
Simcoe District (cont'd)						
Wilson Tract	6	320.7	0	-100	19	23
Checks	3	500.7	24.0	-95	62	77
Backus Tract	9	94.3	1.1	-99	22	19
Checks	1	89.0	17.0	-81	39	50
Charlotteville Twp	5	354.4	1.0	-99	41	35
Checks	3	500.7	24.0	-95	62	77
Earl Tract	7	236.4	0.9	-99	22	20
Checks	3	500.7	24.0	-95	62	77
Cambridge District						
Dundas Valley	9	54.3	1.9	-96	37	41
Checks	3	50.3	445.7	+786	67	91
Chatham District						
Wheatley Prov. Park	8	18.7	4.4	-76	19	17
Checks	2	19.5	1.0	-95	34	45

[a] rO = red oak

[b] wO = white oak

[c] C.A. = Conservation Authority

Table 9. Gypsy moth: District summaries of egg-mass reduction and foliage protection in spray (2 application of *B.t.* at 30 BIU/2.0L/ha) and check plots

District	n	Egg-mass per .01 ha		% Change	% Defoliation	
		1989	1990		r0	v0
Brockville	12	18	2	-88	14	15
Checks	8	156	5	-97	15	23
Carleton Place	27	79	7	-91	17	20
Checks	7	29	5	-81	28	-
Napanee	38	75	1	-99	18	14
Checks	4	20	0.5	-98	13	15
Tweed	5	41	4	-90	40	17
Checks	-	-	-	-	-	-
Lindsay	5	140	3	-98	25	18
Checks	8	74	12	-84	30	25
Maple	7	40	4	-89	45	-
Checks	3	47	210	+349	66	-
Huronia	20	157	61	-61	39	-
Checks	9	85	54	-36	64	-
Cambridge	9	54	2	-97	37	41
Checks	3	50	446	+785	67	91
Niagara	15	15	0	-100	32	34
Checks	8	211	12	-94	43	56
Simcoe	52	222	3	-98	24	26
Checks	50	34	66	+92	71*	
Chatham	8	19	4	-77	19	17
Checks	1	1	0	-100	15	30
Overall	198	66	9	-87	26	22
Checks	101	90	109	+21	41	32

* Includes r0 and v0

Table 10. Gypsy moth: 1989 and 1990 egg-mass densities in sprayed (2 applications B.t.) and unsprayed plots in old (>2 yr.) and new (<2 yr.) infestations in Ontario.

	Avg. Egg-masses per .01 ha					
	Sprayed		%	Checks		%
District	89	90	Change	89	90	Change
Old Infest.						
Brockville	18	2	-88	156	5	-97
Lindsay	140	3	-99	74	12	-84
Napanee	75	1	-99	20	1	-98
Tweed	41	4	-90	-	-	-
Overall	66	2	-98	96	7	-93
New Infest.						
Cambridge	54	2	-96	50	446	+785
Chatham	19	4	-77	-	-	-
Carleton Place	79	7	-91	29	5	-81
Huronia	157	61	-61	85	54	-36
Maple	40	4	-89	47	210	+349
Overall	87	21	-76	55	108	+98

Table 11. Gypsy moth: Current red oak (rO) and white oak (wO) defoliation rates in sprayed (2 applications B.t.) and unsprayed plots in old (>2 yr.) and new (<2 yr.) infestations in Ontario, 1990.

	Current Defoliation (%)			
	Sprayed		Checks	
District	rO	wO	rO	wO
Old Infest.				
Brockville	14	15	15	23
Lindsay	25	18	30	25
Napanee	18	14	13	15
Tweed	40	17	-	-
Overall	20	15	20	23
New Infest.				
Cambridge	37	41	67	91
Chatham	19	17	15	30
Carleton PL.	17	20	28	-
Huronia	39	-	64	-
Maple	45	-	66	-
Overall	28	28	52	60

NORTHWEST REGION

STATUS OF IMPORTANT FOREST PESTS AND OPERATIONAL/EXPERIMENTAL CONTROL PROJECTS

Prepared for the

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STATUS OF IMPORTANT PESTS

This report summarizes information on the current status of major damaging forest pests within the Northwest Region during 1990. Mention is made of several pests of lesser importance because of their widespread appearance in 1990, or because they occurred in new or expanded areas. Several major tree diseases such as pine stem rusts, dwarf mistletoe, Armillaria root rot, Hypoxylon canker and various stem decays of aspen, whose status changes little from year to year, are not discussed. Some of these disease problems involve provincial management projects and will be reported on by the provincial representitives at this meeting. Additional information on pest conditions in the Northwest Region can be obtained in the 1990 regional Forest Insect and Disease Survey report now in preparation, or from the provincial representitives.

Spruce Budworm - [Choristoneura fumiferana (Clem.)]

Spruce budworm infestations were reported in all three Prairie Provinces and in the Northwest Territories, mostly within the same areas as reported in 1989. Increases over last year occurred in the Northwest Territories and in Alberta, while decreases occurred in Saskatchewan and Manitoba. The total estimated area with moderate to severe defoliation for the Northwest Region was 264,465 ha in 1990, compared to 277,116 ha in 1989. This following table lists defoliated area estimates by provincial/territorial jurisdiction.

Areas moderately-severely defoliated (ha) by spruce budworm during 1988-1990.

YEAR	ALBERTA	SASKATCHEWAN	MANITOBA	NORTHWEST TERRITORIES
1988	61,050	31,600	30,820	14,350
1989	85,850	34,650	58,016	98,600
1990	109,000	22,580	18,985	113,900

In Alberta, areas of white spruce forests defoliated by spruce budworm occurred in six general locations, four of which were in the northern half of the province, the remainder two in the central part. Two of the infestations in the northern half remained about the same at about 1000 ha each, while the other two increased substantially. The largest of the infestations, in the northern Footner Lake Forest, now extends over 95,000 ha and is in the fourth year of outbreak and is causing some top-kill. Egg-mass surveys conducted by the province in the four northern infestation areas indicate mostly moderate-severe defoliation is expected to occur again in 1991.

In Saskatchewan, infestations occurred at five general locations, two of which were newly reported in 1990. These occurred in the west-central part of the province (10 ha) and in the Cypress Hills (50 ha) in the southwest part of the province. Much of the decrease in area of defoliation reorted this year over last year is due to a salvage cutting program pursued by the province.

Tree damage and egg-mass density surveys were conducted in two of the infestations by personnel of Weyerhaeuser Canada Ltd., Saskatchewan Division. The results of this survey forecast a severe level of defoliation to occur again in 1991, involving some 4500 ha.

In **Manitoba**, there was a substantial reduction in areas moderately-severely defoliated in 1990, compared to 1989. The infestations occurred in the southeast part of the province (Interlake, Lake Winnipeg East and Pineland Forest Sections), especially in Whiteshell Provincial Park and Lake Wanipigow areas. Infestations here have persisted at high levels for several consecutive years. Numbers of male moths trapped in pheromone traps at 13 locations in 1990 are either similar or less than numbers trapped at the same locations as last year. This suggests an overall declining trend. However, results of foliage samples collected at the same 13 locations for egg-mass density estimates have not been completed as yet and may improve the prediction forecasts.

In the **Northwest Territories**, there was some expansion of infestation areas over that reported in 1989, but new infestations were also mapped along the Mackenzie River between Ft. Simpson and Ft. Norman (4,750 ha). In the two other infestation areas, along the Liard River between Ft. Simpson and the B.C. border and along the Slave River, infestations increased in size and in intensity. This year for the first time, spruce foliage samples were collected at two locations in the Liard River infestation for egg-mass density estimates; moderate to severe defoliation is forecast to occur at both locations in 1991.

Aspen Defoliators - Forest Tent Caterpillar; Bruce Spanworm; Large Aspen Tortrix (*Malacosoma disstria*; *Operophtera bruceata*; *Choristoneura conflictana*)

The current outbreak of the forest tent caterpillar continued in all three Prairie Provinces, spread over a composite land area of 4.394 million ha, some of which also supported varying degrees of large aspen tortrix, Bruce spanworm and other minor species. Defoliation by mainly Bruce spanworm also occurred over an additional 3.468 million ha of land area in Alberta, while defoliation by mainly large aspen tortrix occurred in northern Alberta and in western Manitoba. The estimated areas defoliated in each province are given in the following table. No aspen defoliation was reported in the Northwest Territories.

Areas of aspen defoliation (ha) in the three Prairie Province during 1988-1990.

YEAR	ALBERTA	SASKATCHEWAN	MANITOBA
1988	13,830,000	4,660,200	52,836
1989	5,899,000	3,953,700	325,045
1990	6,542,150	1,435,395	30,718

The total land area over which forest tent caterpillar defoliation occurred was decreased considerably in all three Prairie Provinces. In Alberta, areas of defoliation occurred mainly in the east-central part of the province and in the Peace River area, covering a total land area of about 3,074,375 ha or about 53% of the total of aspen defoliation in the province. Defoliation by Bruce spanworm occurred in central and western Alberta, covering a land area of 3,467,775 ha.

In Saskatchewan, a total area of 1,304,611 ha was mapped with defoliation due mainly to the forest tent caterpillar, while an additional area of 130,784 ha was due mainly to the large aspen tortrix.

In Manitoba, defoliation by mainly forest tent caterpillar covered an estimated area of 15,178 ha in the Interlake and southeastern parts of the province, and an additional 15,540 ha of aspen defoliation in the Duck Mt. area in western Manitoba was due mainly to the large aspen tortrix.

Egg-band surveys, conducted this fall in all three provinces suggest a continued downward trend of forest tent caterpillar populations in 1991.

Jack Pine Budworm - (Choristoneura pinus Free.)

No infestations were reported across the region for the second consecutive year. Monitoring was continued in Manitoba by Natural Resources personnel using pheromone traps and branch samples for egg-mass densities.

Larch Sawfly - [Pristiphora erichsonii (Hartig)]

Defoliation of native tamarack stands by the larch sawfly was less extensive in the Northwest Territories than reported in 1989. Patches of light defoliation occurred in the Ft. Smith area while extensive areas of moderate to severe defoliation occurred along the Mackenzie River between Norman Wells and the Arctic Red River. A small area of light defoliation also occurred in north-central Alberta, north of Lesser Slave Lake.

Mountain Pine Beetle - (Dendroctonus ponderosae Hopk.)

Infestation areas of concern in the Northwest Region occurred in Kootenay and Yoho National parks, in southwestern Alberta, and in an area west (Mt. Robson Prov. Park) of Jasper National park. In the latter area of Mt. Robson Prov. Park, some 90+, 1990-infested lodgepole pine have recently been discovered and are slated for removal this winter.

Aerial surveys over Kootenay and Yoho National Parks in 1990 indicate active mountain pine beetle populations in both parks. Recent tree mortality due to mountain pine was estimated as 9,965 and 110 for the two parks, respectively.

In southwestern Alberta, commercial semiochemical tree baits were deployed for detection of low endemic or new invading beetles in several mature stands of lodgepole pine. Only a few new trees with light new attacks were observed, indicating a further decline in the beetle population. No new infested trees were observed in Waterton Lakes National Park.

Spruce Beetle - [Dendroctonus rufipennis (Kirby)]

A small infestation consisting of several hundred dead white spruce were reported in several blocks of residual uncut spruce in north central Alberta. The infestation is believed to have started in patches of windthrow.

Cankerworms - [Alsophila pometaria (Harris); Paleacrita vernata (Peck)]

High populations of spring and fall cankerworms have been present in many of the urban (eg., Winnipeg, Regina, Saskatoon, Medicine Hat, Lethbridge) centres during the past two years, prompting control programs to be put into place by foliage spray application and tree banding. The main tree species affected include Manitoba maple, American elm, Siberian elm, green ash, birch, and various fruit tree species.

Gray Willow Leaf Beetle - [Tricholochmaea decora (Say)]

High populations of the gray willow leaf beetle were prevalent across the northern half of Saskatchewan and Alberta, and extended into the Northwest Territories along the Liard River to Ft. Simpson. The beetle caused extensive browning of willow leaf foliage by mid-summer.

Lodgepole Terminal Weevil - (Pissodes terminalis Hopping)

This weevil caused a marked increase in incidence of leader kill of young lodgepole pine in western-central Alberta in 1990.

Needle Rusts of Spruce - (Chrysomyxa ledicola Lagh.)

Infection of the current year needles of mainly white spruce was common and often severe throughout much of central and northern Alberta, in central Saskatchewan, and was observed in patches of varying intensity northward in the Northwest Territories as far as Inuvik.

Poplar Leaf Diseases - (Melamposora medusae Thuem.; Marssonina spp.)

Leaf rust and leaf spot diseases of aspen and poplar were common in central and northern parts of Alberta, and caused early leaf browning.

Dutch Elm Disease - [Ceratocystis ulmi (Buis.) C. Moreau]

The distribution of DED contimued to spread and intensify in Manitoba and was reported in new areas near Estevan, Saskatchewan. In Manitoba, the disease is now widespread in such urban centres as Winnipeg, Brandon, Portage La Prairie, Morden, Winkler, Dauphin, Steinbach and Selkirk. Overall, 14,818 high-hazard and DED-infected elms were identified for removal as part of the provincial and municipal control programs. This year for the first time, some 3000 native elms in the Estevan area of Saskatchewan have been identified as high-hazard or diseased and are slated for removal.

Spruce Budworm Operational and Research Spray Trials in 1990

Two provinces, Manitoba and Alberta, conducted operational aerial spray trials against the spruce budworm, using the Bt product "Futura". In Manitoba, the Dept. of Natural Resources treated about 5000 ha of spruce-fir forests including about 1000 ha in provincial parks in the southeastern part of the province. The control results and defoliation protection were considered unsatisfactory.

In northern Alberta, the Alberta Forest Service conducted aerial spray applications of Bt over some 10,000 ha within three Forest Districts. The product, Futura XLV-HP was used at 0.9 l/ha (30 BIU's/ha) and dispersed with Micronair AU4000 atomizer nozzles. The spray was timed for peak fourth instar larvae. However, defoliation protection and levels of larval mortality were considered unsatisfactory for adequate control.

At one of the spray sites (Hawk Hills) two treatment blocks were laid out for research studies of aerial applications of two Bt products (Futura XLV-HP on 500 ha at 33 BIU's/l and Futura "O" an ultra high potency formulation of 60 BIU's/l. An additional block was established as a control. This study was established as a cooperative program of Alberta Forest Service and Forestry canada. Various data were obtained in the study, including host phenological observations, budworm population densities before and after spraying, weather data, defoliation estimates and Bt droplet characteristics on the needles. The preliminary results indicated no significant differences between treatment and control blocks in larval densities and defoliation reduction. Various potential problems related to the poor results were identified.

ALBERTA SPRUCE BUDWORM MANAGEMENT PROGRAM IN 1990

H. Ono, Alberta Forest Service

In 1990, there were major spruce budworm outbreaks at Chinchaga River (95,000 ha), Bovine Creek and House River (12,145 ha), Hawk Hills (1000 ha), and Eaglesham (1,200 ha). The budworm management program in 1990 composed of:

a) Aerial spraying of bacterial insecticide, B.t., to reduce the defoliation thus keeping the severely infested trees alive.

b) Presalvage harvesting to reduce the potential economic losses, should the trees begin to die due to severe budworm infestations.

B.t. was sprayed as currently recommended (30 BIU/ha) by using small fixed wing aircraft fitted with Micronair AU4000 atomizer nozzles. Presalvage harvesting of 153,000 M^3 of mature timber is scheduled to begin in the winter of 1990.

Limited phenological study data showed that a given stage of a larval instar/bud development stage could occur over 3 or more weeks.

The pretreatment larval counts were high (over 20 larvae per 45 cm branch tip). The B.t. droplet counts on the needles were very low (mean of 0.025 droplets per needle). The posttreatment counts were considerably lower (over 50%) in some treated plots but the treatment efficacy was low due to a similar drop in larval counts in the check plots. Defoliation was severe-extreme (70% - 90%) in most of the treated as well as the check plots. These results may be due to the low B.t. droplet deposits on the needles, high pretreatment populations, suboptimal spray weather and the prolonged occurrence of the larval instars.

Aerial surveys showed further expansion of Chinchaga infestation (79,000 ha to 95,000 ha) and House River/Bovine Creek infestation at Lac La Biche (4,230 ha to 12,145 ha). Egg mass samples indicated some reduction in the severity of defoliation in the sprayed blocks in 1991. In House River/Bovine Creek the budworm infestation is expected to be severe in 1991.

Further refinement of the currently used budworm control tactics and sampling techniques, field testing of different B.t. spraying techniques and formulations, and the use of egg parasitoids are being suggested as future strategies to manage the spruce budworm in Alberta.

Table 1. Major Outbreaks of Spruce Budworm in Alberta - 1990

LOCATION	EXTENT (ha)			SEVERITY OF DEFOLIATION		REMARKS
	1989	1990	Change	1990	*1991	
Chinchaga River, Footner Lake	79,000	95,000	20.3%	**M-E	M-S	4th year with some top kill.
Eaglesham, Grande Prairie	1,100	1,200	9.1%	L-E	L-S	4th year with some dying trees.
Hawk Hills, Peace River	1,000	1,000	-	M-S	L-S	2nd year infestation.
House River & Bovine Creek, Lac La Biche	4,200	12,145	289%	L-S	S-E	Fast spreading and cause for concern.

* Projections based on egg mass sampling

** Defoliation categories:

L-E = Light to extreme (0% - 100%)
L-S = Light to severe (0% - 70%)
M-E = Moderate to extreme (51% -100%)
M-S = Moderate to severe (51% - 70%)

TABLE 2. DATA SUMMARY: B.t. SPRAY ON SPRUCE BUDWORM INFESTATION AT CHINCHAGA RIVER - 1990

	Larvae/45 cm branch[b]		Mortality (%)	Defoliation	Egg Mass		Prediction on 1991 Defoliation
	Prespray	Postspray	Obs[c]	Obs[b]	Per 45 cm branch[b]	Per 10m^2 foliage	
Treated[a]							
1.	24.7	9.0	53.3	98.8	3.5	337	S
2.	12.0	4.8	49.6	96.5	2.3	190	M-S
3.	11.0	4.0	59.9	95.8	2.8	182	M-S
4.	29.5	16.8	25.2	97.3	3.2	343	S
5.	46.3	16.0	52.5	97.3	3.2	299	S
6.	43.5	20.0	37.8	93.0	2.3	148	M-S
7.	12.2	13.5	33.3	95.5	2.2	172	M-S
8.	42.0	18.5	45.3	93.9	7.8	476	S
9.	35.3	9.3	67.6	79.5	3.5	248	S
Untreated							
10.	7.8	0.5	92.8	**	**	***	-
11.	73.0	24.8	56.2	92.9	6.3	516	S
12	21.3	9.2	49.5	94.7	10.3	601	S
13.	68.3	20.7	48.9	97.8	4.5	434	S
14.	22.5	13.7	51.2	98.1	3.8	273	S
15.	59.3	12.7	79.1	84.1	5.3	366	S

a Futura XLV-HP, at 0.9 1/ha (30 BIU/ha) sprayed using 6 Micronair AU4000 nozzles on a small spray plane.

b Mean of six 45 cm branch tips per plot.

c Calculated on data standardized per 10 m^2 of foliage basis.

d Defoliation (Fette's method)

L = Light (less than 30%)

M = Moderate (31-50%)

M-S = moderate - severe (51-70%)

S = Severe (71-90%)

E = Extreme (over 90%)

* No Data

Table 3. Data Summary; B.t. Spray on Spruce Budworm Infestation at Eaglesham - 1990

Treated[a]	Larvae/45cm branch[b] Prespray	Larvae/45cm branch[b] Postspray	Mortality[c] (%)	Defoliation[b] (%)	Egg masses per 45cm branch tip	Egg masses per 10m^2 of foliage	Prediction on 1991 defoliation[d]
1	46.8	28.8	30.8	98.1	15.8	828	E
2	30.8	10.7	54.1	**	**	**	-
3	53.3	30.5	25.3	76.0	3.7	323	S
4	22.8	8.8	47.2	**	**	**	-
5	15.2	4.3	71.2	**	**	**	-
6	9.2	4.8	33.3	41.3	2.2	160	M-S
7	39.8	21.7	36.4	73.1	1.2	67	M
Untreated							
8	22.2	14.7	23.1	51.0	4.0	269	S
9	20.2	13.2	17.8	**	**	**	-
10	35.0	10.0	65.9	99.7	6.0	353	S

[a] - Futura XLV-HP at 0.9 l/ha (30 BIU/ha) sprayed using 4 micronair AU4000 nozzles per small spray plane

[b] - Mean of 6 branch tips

[c] - Calculated from data standardized to 10 m^2 of foliage basis

* - No data

[d] - M = Moderate (31 - 50%); M-S = Moderate to Severe (51 - 70%); S = Severe (71 - 90%); E = Extreme (over 90%)

Table 4. Preliminary Data Summary: B.t. Field Trial at Hawk Hills - 1990

Treatment & Plot No.	Larval Population[a] Prespray	Larval Population[a] Postspray	Mortality[b]	Defoliation[c] (%)	Egg masses[c] per 10m^2 of foliage	Prediction[d] on 1991 defoliation
Futura XLV-HP						
(0.9 l/ha = 30 BIU/ha						
1	29.1	7.8	73.2	81.7	228	S
2	9.0	7.3	17.1	100.0	20	L
3	16.0	2.3	85.6	92.9	156	M-S
4	9.8	2.0	79.6	74.1	124	M-S
Futura "O"						
(0.5 l/ha = 30 BIU/ha)						
5	18.4	7.4	59.9	68.3	304	S
6	12.6	2.8	77.1	100.0	89	M
7	11.4	4.8	59.0	100.0	179	M-S
8	17.7	6.3	63.4	100.0	177	M-S
Untreated						
9	8.6	5.3	36.0	100.0	757	S
10	17.7	14.3	19.1	100.0	353	S
11	24.4	12.4	51.8	100.0	226	S
12	11.5	4.9	54.5	99.8	260	S

[a] - Mean of 36 branch samples per plot

[b] - Calculated on data transformed to number per 10 m^2 of foliage

[c] - Mean of four 45 cm branch tips per plot

[d] - L = Light (less than 30%); M = Moderate (30 - 50%); M-S = Moderate to Severe (51 - 70%);
S = Severe (71 - 90%)

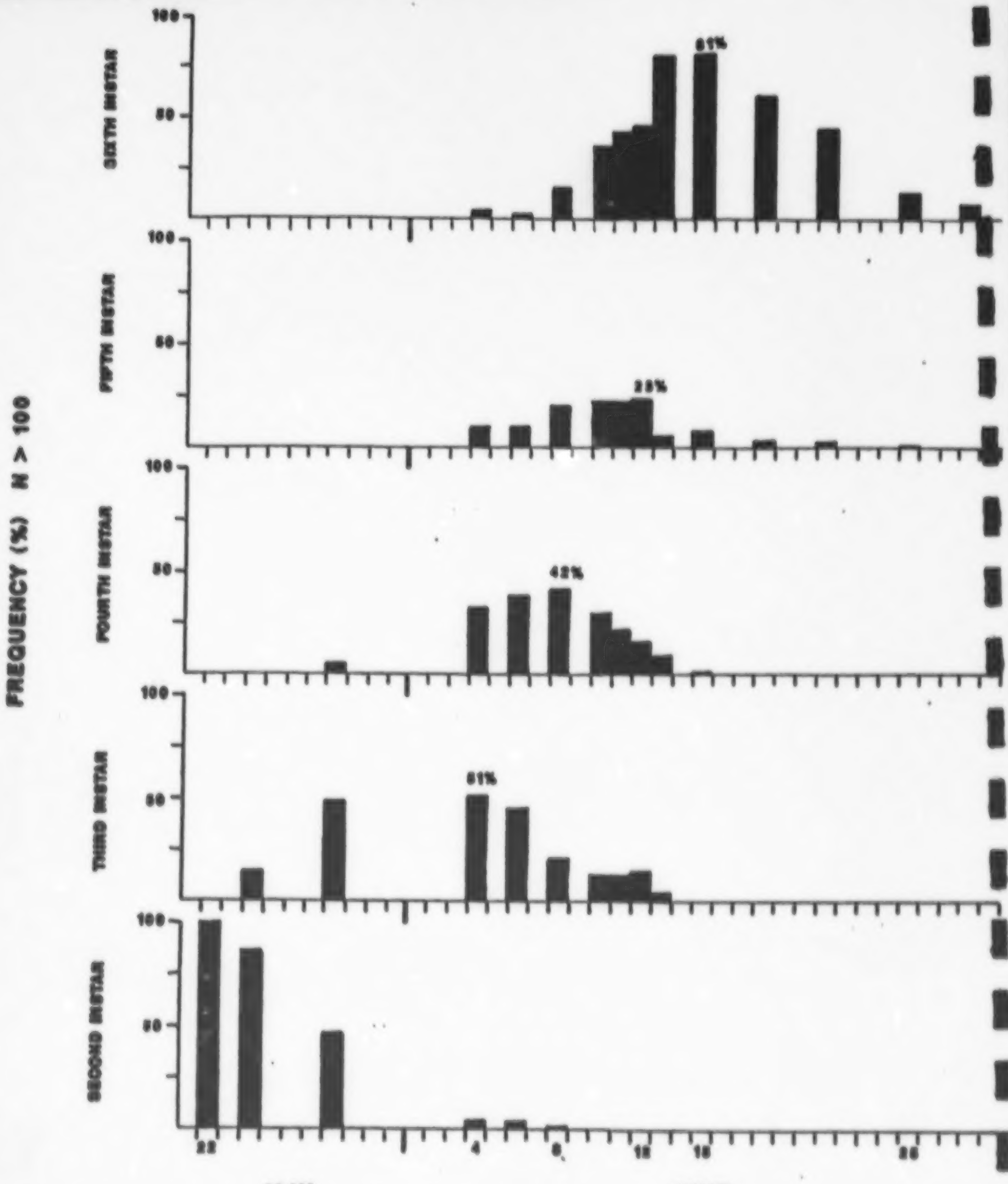

FIGURE 1. PHENOLOGICAL OBSERVATIONS ON SPRUCE BUDWOR

CHINCHAGA RIVER - 1990

FOREST PESTS IN MANITOBA

PREPARED FOR THE
18TH ANNUAL FOREST PEST CONTROL
FORUM
NOVEMBER 20-22, 1990

OTTAWA

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Spruce Budworm

The spruce budworm, *Choristoneura fumiferana*, infestation in eastern Manitoba decreased in size and intensity in 1990. Approximately 18,985 ha of white spruce/balsam fir forest suffered moderate to severe defoliation within the Abitibi-Price Forest Management License, Nopiming, Whiteshell and Hecla Island Provincial Parks. An aerial spray project was implemented for an area of 5,674 ha including both commercial and high use recreational forest.

Pre-Spray Survey

The pre-spray survey was carried out June 4 to 7, 1990. The survey confirmed the necessity for insecticide application and determined the appropriate application timing. Both larval development and current shoot development were assessed for white spruce and balsam fir. Pre-spray populations were as follows:

Treatment	Larvae per 45 cm Branch
2 applications of 20 B.I.U. (Bird, Booster, Flanders, Beresford L.)	10
1 application of 30 B.I.U. (Manigotogan, Happy, Long, Quesnel L.)	8
untreated	14

Application

The earliest spray blocks were opened on June 7, coinciding with larval development of 3.5 and shoot development index of 4.0 (Auger's Class). The majority of the application was done between June 12 to 15 corresponding with peak 4th instar larval development and Auger's Class 5.0.

The biological insecticide Futura XLV (*Bacillus thuringiensis*) was applied undiluted. There were two treatments, a single application of 30 B.I.U./ha (volume of 2.03 l/ha) on 3,050 ha and a double application of 20 B.I.U./ha (volume 1.35 l X 2 = 2.70 l/ha) on 1,312 ha. Three Cessna A188B Ag Trucks equipped with six Micronair AU 5000-2 rotary atomizers were used for the application. The swath width was 50 metres. Two Cessna - C172 aircraft were used for navigation.

Post-Spray Survey

Post-spray surveys were carried out June 19 to 21, 5 days following spray application. Larval reductions due to insecticide (Abbott's formula) was as follows:

Treatment	Abbott Mortality
2 applications of 20 B.I.U.	
white spruce	52%
balsam fir	24%
1 application of 30 B.I.U.	
white spruce	15%
balsam fir	0%

Defoliation assessments indicated that no appreciable foliage protection was achieved.

Defoliation levels were as follows:

2 Treatments @ 20 BIU - White Spruce/Fir 37% Defoliation

1 Treatment @ 30 BIU - White Spruce/Fir 21% Defoliation

Untreated White Spruce/Fir 29% Defoliation

Defoliation Predictions for 1991

Egg mass surveys were carried out in August and September, 1990 in the Abitibi-Price F.M.L., Nopiming and Whiteshell Provincial Parks. Moderate defoliation is predicted for all surveyed areas including Falcon, Westhawk, Dorothy, Bird, Booster, Flanders, Manigotogan, Long and Beresford Lakes.

Jack Pine Budworm Pheromone Study

Since the 1984-1985 outbreak, jack pine budworm, (*Choristeneura pinus pinus*), populations in Manitoba have remained at endemic levels throughout the province. Monitoring the adult males of jack pine budworm began in 1985. This procedure is being evaluated as a supplemental technique to branch collection and assessment at endemic population levels. Budworm populations at twelve locations are being monitored throughout Manitoba.

In 1990, as in 1989, the 0.03 microgram concentration of pheromone lure was tested in two trap types (Pherocon 1C and Multipher). This year, the total adult moth counts decreased by 40% versus 1989 numbers. Until the present, the total number of captured moths had been increasing since 1987. The following table shows the total male moth captures for the 0.03 microgram concentration per location for the Pherocon 1C traps:

Location	Total Number of Moths Captured per Year					
	1985	1986	1987	1988	1989	1990
Sandilands Prov. Forest	208	21	5	60	44	8
Spruce Woods Prov. Park	558	184	184	123	226	112
Whiteshell Prov. Park	50	48	18	28[1]	19	0
Belair Prov. Forest	38	43	15	47	13	0
Nopiming Prov. Park	133	39	5	44	40	4
St. Martins	559	64	2	2	16	1
Porcupine Mtn. Prov. Forest	186	7	0	3	7	6
Moose Lake	63	2	0	3	2	17
Reed Lake	46	4	0	1	4	2
Kississing	76	4	0	5	15	20
Thompson/Wabowden	31	2	0	7	5	0
Lynn Lake	112	1	0	0[2]	0[3]	
Grand Rapids						9
TOTALS	2060	419	229	323	391	179

[1] 50% of traps damaged.

[2] Plot relocated to Wabowden in 1988.

[3] Plot destroyed by fire, only 2 traps recovered. Plot relocated to Grand Rapids in 1990.

Results of the branch assessment from all pheromone locations indicated no increase in defoliation or egg mass numbers.

In addition to the permanent locations above, pheromone traps were established at eight jack pine budworm monitoring sites in the Sandilands area. Two of these sites captured a much higher than average moth number for the area. Results from the branch assessments of all eight sites showed no increase in defoliation but three egg masses were found.

Western Gall Rust Resistant Jack Pine Study

A cooperative project between Forestry Canada and Manitoba Natural Resources began in 1988 to identify superior jack pine families, in an established pedigreed seed orchard, for relative resistance to western gall rust. These families could then be excluded from the ongoing jack pine improvement programs. Western gall rust is a disease of jack pine that can lead to serious volume loss, especially in young plantations.

Cones were collected during the 1990 spring season from field-resistant and field-susceptible families in the Marchand, Manitoba test plantation. Seed was extracted, grown and the seedlings, several weeks old, were then inoculated with western gall rust spores from Manitoba sources. The inoculation experiments occurred at Forestry Canada, Edmonton. Another ongoing trial was the inoculation of young seedlings from the original parents with spores from several different sources. Final assessment of the seedlings' reaction to inoculation will be completed in January 1991.

Controlled crosses were conducted between field-resistant and field-susceptible families at the Belair, Manitoba family test plantation. Crosses between selected families will occur again in 1991 at the same location.

Information gathered on susceptibility to western gall rust will be used to evaluate the families in the current pedigreed seed orchard and to rank families in the province's second generation program.

Western Gall Rust

In 1985, approximately 150 hectares of 24 year old jack pine was thinned near Dragline Lake in the Duck Mountain Provincial Forest. The incidence of western gall rust (Endocronartium harknessii) is high in this area with approximately 50% of the trees having main stem galls prior to thinning. Tree spacing, growth and form were the major thinning criteria. Little or no consideration was given to the presence of rust. Consequently, main stem rust infections are still prevalent (approximately 40%) after thinning. Elongate (often 1 to 2 metres in length) flattened cankers are frequently associated with main stem galls. These galls/cankers have the potential to cause growth loss, deformity and girdling or breakage of the main stem. Considering the stand has been thinned to optimum stocking for this age class, a significant reduction of stems per ha would translate into substantial volume loss at rotation.

A study was initiated to monitor the impact of main stem rust infection on stand productivity and to determine if selective thinning using rust as a major criteria could be carried out without leaving the stand understocked. Two 400 m^2 permanent plots were established in both the thinned area and in a nearby heavily infected unthinned stand of the same age. An area 0.25 ha in size was thinned in this stand using main stem gall rust as a major thinning criteria. Two 400 m^2 plots will also be established in this thinned area. Tree growth measurements, vigour assessments, and main stem infection severity ratings are to be done in all plots. Over time, stand productivity will be compared between no treatment, thinning without using rust as a criteria and thinning where rust infection is one of the major criteria.

Red Pine Dieback

In 1988, during routine pest surveys in renewed forests, a tip dieback condition was discovered in a 32 year old red pine plantation in the Sandilands Provincial Forest of southeastern Manitoba. The condition tends to occur in fairly discrete infection centres with a gradient of lightly infected trees on the periphery to chronic infection towards the interior. Chronically infected trees are often stunted, have lost their main stem dominance, have significant stem taper, and become bush-like in their growth form. There is no noticeable tree mortality associated with this condition as infected trees remain quite vigorous. Damage appears to be mainly in the form of growth loss and deformity.

In May of 1990, 3 permanent plots (900 m^2) each were established to monitor the impact and spread of this condition. Initial height measurements show significant differences between chronically infected trees and those having light or no infection. The average height of trees having chronic infection was 5.2 metres (based on 63 trees), while the average height of all uninfected plot trees was 7.6 metres (based on 152 trees). The level of infection in each of the plots is 56%, 49%, and 30%. Two of the plots were placed well within infection centres, while the third one was placed on the periphery of a centre.

In an attempt to determine the causal organism, cloth sleeves were securely placed on groups of branches at 3 different times during the growing season, mid June, late June and mid July. In early August, bud condition was compared between sleeved and paired unsleeved branches. Bud mortality was 5% on branches which were sleeved in mid and late June compared to 25% bud mortality on unsleeved branches. On those branches which were sleeved in mid July, the bud mortality was equal to that of unsleeved branches (approximately 40%). The sleeves placed on branches in mid and late June effectively excluded infection from occurring.

By early August 1990, this year's symptoms became visible. The tips of current shoots browned off. Needle loss and bud kill was associated with the tip browning. Samples from the dead buds and browned tips were then cultured. The cultures derived from all samples appear to be very homogeneous. Additional samples from other plantations have been collected for purposes of culturing. The causal organism is as yet unknown.

Stem Cankers in Red and Jack Pine

In 1988, during routine plantation pest surveys in Sandilands Provincial Forest, severe stem cankering was detected in jack pine (20 to 22 year old) and red pine plantations (18 to 32 year old). On both species the cankered portions of the stem are often flattened and/or twisted. The bark usually remains in tact concealing the canker. Cankers range in length from a few centimetres to 2 metres in length. The cankers eventually cause girdling resulting in top kill or tree mortality. Substantial mortality centres have developed in some cases indicating the disease has been present for a number of years. In the oldest of the surveyed plantations (32 year old red pine) infection centres have coalesced resulting in substantial volume loss.

In May 1990, permanent plots (two 400 m^2 in 22 year old jack pine and two 900 m^2 in 32 year old red pine) were established within infection centres to monitor the spread and impact of the stem cankering. The variation in plot size was due to considerably greater density in the jack pine plantations. Within the jack pine plots the percentage of trees having main stem cankers is 19% and 51%, while in the red pine it is 35% and 44%.

A number of canker samples were collected from both the jack pine and the red pine plantations. Culturing and isolations from the jack pine samples are near completion. Ten isolates have been selected which will be tested as possible causal organisms. The culturing of red pine canker samples is still in progress. Greenhouse inoculation of seedlings and field inoculations of 10 to 20 year old trees is planned for both host species in 1991.

Pest Assessment of Permanent Sample Plots (P.S.P.'s)

Since 1986, the Silviculture Section of the Manitoba Forestry Branch has placed permanent sample plots in recently established plantations of the major tree species. Up to 45 plots are being maintained per species, taking into account the different types of planting techniques and silvicultural site preparation methods. Forest Protection has established a survey regime within the Silviculture plots to relate pest damage and occurrence with growth & yield results.

The permanent sample plots are circular 50 m2 plots arranged in a grid pattern across part of each plantation, at a density of one plot per hectare for the selected area. Similar to tree measurements, damage and causal pests will be assessed every 3 years of growth from age 3 until age 21.

In 1990, the 1986 P.S.P's were assessed. These included 25 plantations or 210 P.S.P.'s with White spruce, Black Spruce, Red pine, and Jack pine as the planted tree species. The data will be entered on a program called the 'Pest Survey System' or PSS which was developed by Silvacom in cooperation with Forestry Canada and the prairie provinces. In addition, after data collection the two databases from Silviculture and Forest Protection will be amalgamated and analyzed, for provincial purposes.

Renewed Forests - 1990 Pest Survey Report

To date, 1987-1990, 133 renewed forest stands covering 4685 ha have been surveyed in the Province of Manitoba for insects and disease damage. In 1990, the surveyed trees ranged in age from 9 to 54 years. This year, 57 renewed stands totalling 2000 ha were surveyed in the southeastern and western regions of the province.

In the southeast region, several jack pine stands (both hand and machine planted) had a high proportion of leaning trees with j-roots. Other problems evident on jack pine included western gall rust (Endocronartium harkinessi), topkill, armillaria root rot (Armillaria sp), and blowdown. Main stem cankering on red pine resulted in loss of main stem dominance, top kill and large stand openings due to mortality. White spruce stands often had poor growth related to unsuitable site conditions. Moderate spruce budworm (Choristoneura fumiferana) defoliation occurred on white spruce in the Whiteshell area.

The western region had severe rabbit browse damage and competing vegetation in white spruce - many stands will require replanting. Hail damage caused leader and top kill on Siberian larch and jack pine. Other problems on jack pine included the Warren root collar weevil (Hylobius warrenii) on natural regeneration and serious leaning problems and dwarf mistletoe (Arceuthobium americana) infection in hand-planted stands. Trembling aspen is considered a marketable species in the western region, and the more damaging pests observed in 1989 and 1990 were hypoxylon canker (Hypoxylon mammatum) and the large aspen tortrix (Choristoneura conflictana).

Dutch Elm Disease - 1990

The Dutch Elm Disease surveillance program was carried out once again during the 1990 summer season. This survey program encompasses 53 cost-sharing communities which represent the focus of Dutch Elm Disease (DED) management program. Five new communities undertook cost sharing agreements this year- Birtle, Hartney, Gretna, Riverton and the Rural Municipality of Wallace. Under the terms of an agreement, the Province of

Manitoba and the communities cost-share DED control programs such as sanitation pruning, basal spraying with chlorpyrifos and replacement planting. The province is responsible for the survey of diseased and dead elm trees within cost-sharing communities, except the City of Winnipeg. It is responsible for removal of infected elms from all cost-sharing communities except those of Brandon and Winnipeg.

The Elm Guard Program gained momentum this year and now encompasses 15 communities involving 128 members. This program involves the participation of volunteers who check their areas and report any trees suspected of having DED to provincial surveillance crews. This program along with the provincial survey goes a long way towards improving the monitoring of DED and allows interested members of the public to have more input into DED management in their communities.

During the 1990 provincial survey, 14,818 elms were marked for removal. Of this total, 985 trees were diagnosed as having DED while a further 13,833 trees were classified as hazards i.e. were decadent to the point that they were capable of supporting elm bark beetle breeding activity. Many of these hazards likely died as a result of DED. In the city of Winnipeg 11,088 trees are slated for removal, 968 of which were diagnosed as having DED and a further 10,120 classified as hazards. Other major urban centres with disease included Brandon, Portage La Prairie, Morden, Winkler, Dauphin, Steinbach and Selkirk.

Dutch Elm Disease is widespread throughout most areas of southern Manitoba. As in 1989, Dauphin remains the northwestern disease front. Large numbers of diseased trees have been identified around the northern escarpment of Riding Mountain National Park along the Wilson, Vermillion and Ochre Rivers. Estevan, Saskatchewan reported two diseased trees this summer marking it as the western boundary of DED in the prairies. Approximately 3000 elms in a hazardous state have been marked for removal in the Estevan area as part of their DED control program.

In eastern and central Manitoba, many communities experienced an increase in disease levels. Especially hard hit were Morden, Winkler and Morris. Buffer zones around some communities continued to exhibit a high level of disease. Carman, while showing a decrease in the number of required removals within the town, exhibited a large number of diseased and hazardous elms in the vicinity. The towns of Pine Falls, Pinawa and Lac Du

Bonnet continue to show a low incidence of DED and Manitou, which had one diseased tree in 1989, reported no diseased trees this year. In western Manitoba the city of Portage La Prairie experienced an increase while Brandon showed a decreased incidence of DED within the city. The buffer zone of Brandon ,like that of Souris, however, has many diseased and hazardous trees slated for removal. Most western communities continued to indicate a low incidence of disease. As in past years, the towns of Boissevain, Deloraine, Gilbert Plains, Killarney, Melita, Reston, Russell and Virden showed no evidence of disease.

River areas continue to have high levels of DED, especially along the Red and Assiniboine Rivers. The Boyne River near Carman and the Souris River in southwestern Manitoba remain extensively infected. Although DED continues to rise in some communities with cost-sharing programs, the incidence of disease remained comparatively low. Less than two percent of elms in Winnipeg and Brandon were infected with DED. Severe drought conditions which have prevailed since 1988 continue to contribute to the stress on elm trees which has been reflected in higher than anticipated incidence of disease in many areas.

From June 1,1989 to May 31,1990 the Provincial DED Sanitation crews removed 18,756 diseased and hazard elms.

Efficacy Trials with the Herbicide "Glowon"

Sanitation, or the removal and destruction of dying and diseased elm trees, is a major component of a successful Integrated Pest Management - Dutch Elm Disease program. It reduces the amount of breeding material available to the native elm bark beetle, which is the major vector of Dutch elm disease in Manitoba. However, due to limitations of personnel, time, accessibility of elms, and costs, sanitation is often practised in urban and high use recreational areas.

A method to supplement the sanitation program which has proven effective in the United States is herbicides. Herbicides are injected into the sapwood of elms, killing them and creating trap trees. Elm bark beetles are strongly attracted to the dying elms and produce broods. However, these broods do not develop to adulthood due to the herbicide-induced drying of the inner bark.

The herbicide Glowon was applied to elms at two locations in Manitoba, in mid-May, when native elm bark beetles are emerging from their overwintering sites. Beetle activity on all the selected study elms was monitored throughout the season using sticky cardboard traps. After cessation of beetle activity in October, several randomly selected elms were felled and sampled. These samples are presently being examined for beetle attacks and brood galleries.

The extent and number of brood galleries and larval development will help determine the effectiveness of the herbicide in reducing and/or eliminating brood production.

PACIFIC REGION - 1990

STATUS OF IMPORTANT FOREST PESTS, EXPERIMENTAL CONTROL PROJECTS AND VEGETATION MANAGEMENT RESEARCH

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ABSTRACT

The status of more than 19 forest pests in 1990 is presented with some forecasts for 1991. These include the declining but continuing populations and significant damage by mountain pine beetle, the decline in black army cutworm, rhizina root disease, and blackheaded budworm, increasing levels of western and eastern budworms, spruce beetle, Douglas-fir tussock moth, western hemlock looper, grey spruce looper, and gypsy moth.

Current research progress and control trials of some of these pests include: biological control research directed to spruce weevil, larch casebearer, winter moth and vegetation management; B.t. trials against blackheaded budworm; pathogenicity testing with pinewood nematode and hazard rating and model systems for mountain pine beetle.

SUMMARY OF IMPORTANT PESTS

The following have been selected as the pests most likely to be of interest to participants. Equally significant in terms of losses are several forest diseases such as root rots, dwarf mistletoes, stem decays, rusts and cankers. However, once established, these are perennial and fluctuate little from year to year and annual surveys are neither practical nor necessary. Controls for such diseases are most practical as preventative treatments combined with stand management practices during the harvest-regeneration phase or juvenile stand tending. Also not included are impacts such as nursery and regeneration losses, most quarantine matters, aesthetics, increased fire hazards, or earlier losses from white pine blister rust.

For more detailed information of these and other pests active in the Pacific Region in 1990, the reader is referred to "Forest Pest Conditions in British Columbia and Yukon" by Forestry Canada's Forest Insect and Disease Survey and published annually by the Pacific Forestry Centre, Victoria, B.C.

Mountain Pine Beetle

The beetle continues to be the most damaging forest insect in British Columbia. The area and volume of lodgepole pine and some western white pine killed by the beetle declined to the lowest level since 1975. Yet, more than 9322 active infestations still cover more than 36 500 ha from the International Border to northeast of Prince Rupert. This is about half the area burned by forest fires in British Columbia in 1990 (76 000 ha) and the volume lost (1.1 million m^3) represents about 5% of the lodgepole pine annually harvested in British Columbia (20.5 million m^3 in 1988).

Active infestations continued throughout the six forest regions in British Columbia. An infestation in the Cariboo Region which developed in 1987 in mature pine at Chilko Lake near the Coast Mountain Range declined to 300 ha this year. Elsewhere, areas containing recently killed mature pine as mapped during the 1990 aerial surveys were: Kamloops Region - 6000 ha, down more than half from 1989; Nelson Region - 23 000 ha, down 28%; down 28% in the Prince Rupert Region at 3950 ha; unchanged in the Prince George Region at 2800 ha; and down less than 5% in the Vancouver Region at 540 ha.

Infestations along the British Columbia-Alberta border and in Glacier and Yoho National Parks were generally stable for the fifth consecutive year. However, numbers of recently-killed pine increased in Kootenay National Park. Cooperative aerial and ground surveys in Mt. Robson Provincial Park and west of Jasper National park located eight new mountain pine beetle-killed pine (faders) and 216 newly attacked trees. Annual cut-and-burn control operations have been implemented since 1985; 230 trees were treated earlier in 1990.

Overwintering mortality was generally less than 10% providing an increasing population for flight and attack in July 1990 (84% of the ratios of progeny to parents at 45 locations were greater than 4.1 indicating increasing populations). The frequency of new attacks on mature lodgepole pine in 41 previously infested stands cruised in four forest regions ranged from an average of 7% in the Prince Rupert Region to 26% in the Nelson Region with a province-wide average of 17%. Current attacks exceeded the 1989 levels in the Kamloops, Nelson and Prince George regions but declined in the Prince Rupert Region. Cruises in declining infestations in isolated areas of the Cariboo and Vancouver regions were discontinued last year due to limited host availability and remoteness. Mountain pine beetle killed increased numbers of mature western white pine in the northern part of the Kamloops Forest Region. Other bark beetles including western pine beetle, Dendoctronus brevicomis, red turpentine beetle, D. valens, and lodgepole pine beetle, D. murrayanae were common, some for a third consecutive year, and contributed to pine mortality in parts of the Kamloops and Nelson regions. Increased attacks by ambrosia beetles, Trypodendron spp., were again widespread in mountain pine beetle infested stands in the western part of the Nelson Region, and northwest of Fort St. James. Pine engraver beetle, Ips pini, which had been common in mountain pine beetle infestations in the interior regions, remained at low levels for a third consecutive year.

Salvage of beetle-killed and adjacent susceptible pine continued at high levels in most beetle-infested Timber Supply Areas. Salvage harvesting of economically accessible beetle-killed pine may be affected by high inventories in a declining market. There were no reports of changes in AAC as a result of increased salvage harvesting.

Spruce Beetle

The area and volume of mature white and Engelmann spruce killed by the beetle in British Columbia increased following seven years in decline. Most of the 2400 ha of infested spruce mapped in aerial surveys, up from 1000 ha in 1989, occurred in more than 130 separate infestations, mainly in the Kamloops Region. The major increase was north and east of Prince George in recent windthrow and standing mature spruce near Carp and Weedon lakes, in the Parsnip and McGregor river drainages, and west of Williston Lake near Mackenzie A new infestation developed in the Adams River drainage in the Kamloops region; infestations continued in the Tulameen drainage west of Princeton and elsewhere in more than 20 widely scattered patches. New attacks in recent windthrow in parts of the Cariboo and Nelson regions, including over about 700 ha in Bowron Lake Provincial Park, could pose a threat to mature stands in 1992. High populations of northern spruce engraver beetle, Ips perturbatus, which infested spruce trap trees north of Prince George, could infest and kill tops of adjacent weakened and even healthy spruce in 1991.

Budworms

More than 193 000 ha of mixed age-class Douglas-fir in three forest regions were defoliated by western budworm, up about 15% from 1989, but down from a peak of 800 000 ha in 1987. Defoliation also intensified being light on 46% of the area, with 52% moderate and 2% severe; compared with 79%, 19% and 2%, in 1989. There were nearly 500 separate areas of infestations.

Areas of expansion included the Okanagan Valley with 120 700 ha, up from 105 000 ha, the Shusvap, Adams, and North Thompson river drainages, and in the Nelson Region west of Revelstoke and north of Grand Forks. Areas of decrease included the eastern part of the Cariboo Region for a second year, the south-western part of the Nelson Region, and near Pemberton in the Vancouver Region.

Parasitism of late-instar larvae at nine locations in two regions averaged 9% overall, range 4 to 23%, similar to 1989 (10%, range 1 to 22%). Tachinids and hymenopterans were common and an entomopathogen, Beauvaria sp., was isolated from larvae in a collection in which 46% were killed, at a site in the West Kootenay. However, these levels are not expected to effectively reduce populations.

The average number of egg masses collected by FIDS at 48 infested stands in three regions were 46% more numerous than in 1989 indicating an overall increase. Defoliation is forecast to be severe at 27 of the sites, mostly in the Kamloops and Nelson regions, moderate at 13, light at 6 and none at two.

Tree mortality and growth loss is variable. About 30% of mixed age Douglas-fir over about 125 ha west of Kamloops, was killed following at least two successive years of severe defoliation. Top-kill up to 3 m on 7% of the trees, and growth reduction of 12%, following three successive years of defoliation, was present in three areas near Pemberton in the Vancouver Region.

Aerial spray trials of Bacillus thuringiensis were discontinued following applications in 1989 over a total of 300 ha in areas west of Penticton, and near Kelowna, in the Kamloops Region.

As part of a study to improve and calibrate detection methods for western budworm, mid- to late-instar budworm larvae and adult males were monitored in four regions at 10 sites still with low populations but a history of budworm outbreaks. Up to 461 larvae/tree were collected per 1 m^2 beating (3 branches on 25 trees/plot) and up to 293 male adults were caught in a total of 53 traps. Further analysis and additional sampling are planned before numbers can be correlated with population potential and damage.

Current foliage, mostly of alpine fir and to a lesser extent of white spruce, was defoliated by eastern spruce budworm over 398 150 ha west and north of Fort Nelson. This is a more than threefold increase over 1989. Defoliation was mostly severe over 26% of the area, moderate on 42%, and light over the remainder. Defoliation for a fifth consecutive year extended into the Northwest and Yukon territories. To protect mature spruce seed production stands and adjacent young stands near Fort Nelson, five blocks totaling 525 ha at three locations were treated with a commercial formulation of B.t. ('Futura', XLV). A smaller operation also by the BCFS in the same area in 1988 was moderately successful. Parasitism of late-instar larvae from two sites was only 10%.

Based on egg samples, defoliation is forecast to be severe in 1991, in the Liard and Fort Nelson river drainages, including the spruce seed production stands.

Defoliation of alpine fir and spruce forests by mature 2-year-cycle budworm was light and moderate over 30 000 ha in 170 infestations in three forest regions. This was up from 11 200 ha in 48 infestations in 1989, a non-feeding year, but less than the 102 000 ha defoliated in 1988, a feeding year. The mature 'on-year' cycle budworm larvae defoliated 14 100 ha in the Cariboo Region, 6750 ha in the Kamloops Region; 8600 ha in the Prince George Region; and a new infestation in the Nelson Region defoliated 600 ha.

Immature 'off-year' 2-year-cycle budworm infested up to 60% of the buds of high elevation fir and spruce at two sites in the West Kootenay. This was down from 1989, when defoliation by mature larvae occurred over 5850 ha in seven areas. Twenty five percent of the buds were infested in drainages on the west side of the Rocky Mountain Trench in the East Kootenay, where stands were defoliated by mature larvae in 1989. There was no visible defoliation of fir-spruce north of Mackenzie in the Prince George Region, where a new area of defoliation was mapped for the first time in 1989 over 11 385 ha.

Larvae and adult male budworm populations continued to be monitored in four regions to improve identification and calibrate methods to detect budworm populations in fir-spruce forests. Up to 650 adult males (avg. 128/trap) were collected in 55 non-sticky traps at 11 sites in three regions, and up to 25 larvae were collected per location (avg. 4). An additional distribution survey collected up to 148 adults in 24 traps at four locations. Further study, however, is necessary before numbers can be correlated with population damage and potential.

Western Blackheaded Budworm

The area of mature western hemlock defoliated by blackheaded budworm near Holberg on northern Vancouver Island, declined to 630 ha in 11 separate patches. This was down, as forecast, from 7400 ha in 1989. Populations in alpine fir in the eastern part of the Prince Rupert Region, collapsed following defoliation of new shoots over 65 000 ha in 1989.

Populations on the Queen Charlotte Islands remained low following their collapse after four consecutive years of defoliation by blackheaded budworm and, to a lesser degree, hemlock sawfly. Cumulative years of tree mortality occurred in 109 patches totaling 4375 ha. The legacy of four consecutive years of defoliation of western hemlock stands on the Queen Charlotte Islands resulted in limited mortality of old growth, but in one young stand mortality of western hemlock reached 42%. Dead trees averaged 45 years old, and 31 cm diameter and had been severely defoliated for two consecutive years. Additionally, top-kill affected 72% of mostly mature plot trees, and radial increment averaged 30% less during the outbreak than during the five years prior to defoliation in 1985. South of Holberg on Vancouver Island, top-kill averaged 1 m on 22% of the immature western hemlock at two sites defoliated by blackheaded budworm in 1988 and 1989.

On northern Vancouver Island defoliation is expected to decline further based on an estimated ten or less eggs per 10 m^2 of hemlock foliage at two sample sites, down from an average of 14 eggs per branch found at 16 sites in 1989. Larval parasitism averaged 43%, (range 31 to 59%), mostly by Ascogaster sp., at three sites. This is up significantly from an average of 13% (range 1 to 51%), in 1989. At three sites in the eastern part of the Prince Rupert Region, larval parasitism by a braconid, averaged 34% (range 2 to 85%).

Grey spruce looper

Western hemlock was defoliated by the looper over 1370 ha in 24 infestations along the east side of the Arrow Lakes in the Nelson Forest Region. This was the first major outbreak by this pest in the region since a minor infestation occurred in hemlock stands near Terrace in 1961. Defoliation was moderate over 1065 ha, light over 230 ha and severe over the remainder. Larval mortality averaged 27% at two sites (range 16-38%), caused mostly by a pathogen, Entomophthora sp. Based on damage assessments and the previous outbreak, growth is not expected to be significantly affected and populations are not expected to continue in significant numbers in 1991.

Western Hemlock Looper

Increased larval populations severely defoliated mostly old growth western hemlock in 7 patches totaling 915 ha north of Revelstoke in the Nelson Forest Region. This was the first defoliation by the looper since a previous outbreak in the region in 1982-83, which resulted in extensive tree mortality and top-kill of mature hemlock. Defoliation is forecast to be mostly severe in 1991, based on an average of 134 eggs per sample (range 14-300) at three sites. Egg parasitism averaged 26% (range 11-38%), at the three sites, but is too low to effectively reduce populations.

Douglas-fir Tussock Moth

Increased numbers of larvae, adults, and egg masses were present in Douglas-fir trees in the Okanagan and Thompson valleys, and for the first time since 1983 in the Fraser Valley. Defoliation of ornamental spruce and Douglas-fir occurred in urban Kamloops for the third consecutive year since the last outbreak collapsed in 1984, and in Penticton for the second consecutive year. Single Douglas-fir trees were severely defoliated in natural forest sites west of Kamloops and near Abbotsford, Chillivack, and Clearbrook in the Vancouver Region, where defoliation occurred during the last outbreak in the early 1980s.

The number of male adults in pheromone-baited sticky traps placed in Douglas-fir stands selected for the greatest historical frequency of outbreaks increased for the fifth consecutive year. About 2263 adult males were trapped in 89 of 104 traps at 18 permanent monitoring sites in the Kamloops Region. This is 17% more than in 1989 when there were 1893 in 77 traps at 16 sites. This indicates that defoliation of Douglas-fir could occur in 1991. Numbers also increased in the western part of the Nelson Region, where 156 adult males were trapped in 12 traps at two locations. An additional 2233 male adults were trapped in 53 of 54 single traps located by FIDS 1 kilometer apart in five areas in the Kamloops Region, up from 1782 at 60 of 76 in 1989 and 478 at 25 of 33 in 1988. A further 1616 male adults were trapped at 79 locations (average 20/trap/location) monitored by BCFS, up from 429 at 52 locations (average 8/trap/location) in 1989. Trapping data, and the presence of egg masses at 8 of 20 sites in the Kamloops Region and at two sites east of Vancouver, indicates the potential for defoliation and possible a spray program in 1991. None is expected in the Nelson Region, where there were no larvae or defoliation and only small numbers of male adults in traps.

Larch Casebearer, Sawfly, and Looper

Larch casebearer populations in western larch stands in southeastern B.C. increased slightly, up from generally light levels similar to the previous three years. Patches of moderate defoliation were common in the Slocan and Arrow lakes drainages in the West Kootenay, but were less common and widespread in the East Kootenay. Defoliation in the western part of the host range in the Kamloops Forest Region was generally minimal. However, light defoliation was recorded for the first time near Sicamous, and increased slightly in widespread pockets in the North Okanagan. At most of the 20 long-term parasite release study sites in the Nelson Region, defoliation was nil to generally light but severe in small pockets at sites near Castlegar and Vernon. Parasitism of casebearer pupae from the 20 sites averaged 14% (range 0-36%), down 20% from 1989. Parasitism by the introduced *Chrysocharis laricinellae* (Ratzberg), averaged 6%, down 12% from 1988, and parasitism by *Agathis pumila* increased 5% to an average of 6%. Larval parasitism at the 20 sites averaged 20%, similar to 1989, and mostly by *C. laricinellae*, *A. pumila*, and to a lesser degree by the native *Spilochalcis* sp.

Since the biological control program against larch casebearer was initiated in 1966, more than 15 000 specimens of *Chrysocharis laricinellae* (Ratzburg) or *Agathis pumila* (Ratzburg) have been released. No releases have made since 1987 and additional releases are not anticipated until the results to date can be further assessed.

Larch sawfly populations declined to generally endemic in previously infested western larch in the southeastern part of the Nelson Region, and in tamarack in the Yukon Territory and near the Yukon border in the northern part of the Prince Rupert Region. Populations in previously defoliated western larch in the West Kootenay, remained at low levels following their decline in 1989. The decline was due to the high incidence of parasitism by a chalcid, *Dibrachys saltans* in overwintering cocoons. Populations which defoliated exotic larch near Haney in the Vancouver Region, at Terrace, and at Prince George, declined following up to four consecutive years of generally light defoliation. Populations which lightly defoliated small groups of larch in Stanley Park in Vancouver for the first time in 1989, were less numerous in 1990 and defoliation was minimal.

Increased larch looper populations defoliated western larch in 190 separate patches totaling 12 000 ha in the West Kootenay, in the Nelson Forest Region. Defoliation was mostly light with moderate in widespread patches from Creston to Fauquier. This was the first significant defoliation by the looper since the first outbreak in British Columbia was recorded in 1977. Larval parasitism averaged 32% at two sites and 15% of the cocoons were parasitized at one site, too low to reduce populations. Based on overwintering cocoon assessments at four sites (average 15/site, range 6-31), light defoliation is forecast to occur in 1991.

European Larch Canker

Formal surveys for the potentially damaging European larch canker in western, alpine, eastern and some exotic larch stands in British Columbia were discontinued in 1989. This followed eight successive years of surveys and no evidence of the disease. A native larch canker continues to be found on immature western larch in the West Kootenay. The distribution of the canker in North America remains limited to New Brunswick and Nova Scotia and several eastern states where small diameter trees have been infected and killed.

Black Army Cutworm

Cutworm populations remained at very low levels this year following a significant decline in previously infested areas in interior British Columbia in 1989. Seedlings were lightly defoliated at two sites slash-burned in the fall of 1989 in the eastern part of the Prince Rupert Region. Elsewhere, larvae were common on deciduous ground cover at an additional two sites in the Prince Rupert Region, and at four of nine previously infested sites in the Nelson Region, and two sites north of Prince George. In 1989, moth catches at these sites ranged from 86 to 1200 (average 422).

The decline was attributed to natural factors, an entomopathogen and natural parasites in 1989, which reduced larval populations by up to 53% at two sites in the Nelson Forest Region, and 47% of the pupae from the Kispiox area in the Prince Rupert Forest Region. In 1990, larval parasitism mainly by Enigorgus sp., averaged 28% at three sites in the Prince Rupert Region, 5% at one site in the Nelson Region, and pupal parasitism was 38% at one site in the Prince George Region.

Cutworms could pose a threat to seedlings in 1991 plantings following slash burning in 1990. This is based on the numbers of male adults in pheromone baited non-sticky traps which exceeded a trial threshold of 500 or more at 8 of 73 sites in parts of three regions. Four of the sites were in the Prince Rupert Region, two in the East Kootenay, and two north of Prince George. Each dry trap was baited with a commercially produced pheromone. Additional years of trapping are necessary before results can be calibrated as a fully functional forecasting tool.

The results of a 3-year study for a system to forecast population fluctuations and the subsequent degree of defoliation, based on numbers of male adults in non-sticky traps, were published this year (Maher, T.F. 1990. Damage appraisal and pheromone trapping studies for the black army cutworm in British Columbia. FRDA Rep., 117. For. Can., Pac. For. Cent., Victoria, B.C. 39 pp).

Rhizina Root Disease

Rhizina root disease infected and killed several hundred newly planted spruce and pine seedlings in 24 of 41 sites burned in late 1989 and examined in parts of the Nelson and Prince Rupert forest regions in 1990. It was the third consecutive year of seedling mortality caused by this disease. Up to 37% (average 13%, down from 27% in 1989) of the seedlings were killed in 15 sites in the Prince Rupert Region; none was found in an additional 11 similarly prepared sites. At four sites in the East Kootenay, about 27% of the seedlings were killed and fruiting bodies were present at an additional five sites, and there were no fruiting bodies in an additional six sites. There was no evidence of the disease or additional seedling mortality at sites where seedling mortality occurred in 1989 in the West Kootenay and north of Prince George, or west of Clearwater in the Kamloops Region, although fruiting was present in 1989, seedlings were not been affected.

Pinewood Nematode

Based on nearly 2000 samples from trees, logs, boards, and potential vectors collected from throughout British Columbia since 1980, this nematode remains extremely low in forests in British Columbia and the Yukon Territory with only individual, predisposed trees affected at a few widely distributed locations. In 1990, 776 samples were extracted and examined from 19 log yards, more than 200 forest sites and 29 mills. In each case more than 100 trees, logs or boards were observed. Only one sample, a white spruce, woodborer-attacked log from Watson Lake, Yukon contained pinewood nematode. Along with five previous positive records this represents only a 0.3% incidence within predisposed trees or logs in this region. Special attention was given to examination of western hemlock and western red cedar in 1990. There was no evidence of the nematode in 319 extractions from both hosts. A single Monochamus woodborer was detected in more than 575 hemlock logs (a 0.17% incidence) examined in 16 coastal storage yards. None were detected in cedar.

Scleroderris Canker

Formal examinations of native lodgepole, ponderosa and whitebark pine in British Columbia, where only the North American strain of this fungus was collected at only four sites, were discontinued following surveys throughout B.C. in 1988, which were all negative. This pathogen, which has caused extensive mortality of young pines in plantations and nurseries in eastern Canada and the United States, was found only rarely as a lower branch saprophyte in British Columbia between 1968 and 1978 near Penticton, Canal Flats, Castlegar and Kimberley.

Gypsy Moth

About 8000 sticky traps were monitored throughout British Columbia in the fifteenth year of a cooperative program with Agriculture Canada (Plant Health), Forestry Canada - FIDS, and the B.C. Ministry of Forests.

About 121 males were trapped, mostly on the Saanich Peninsula, in 16 areas in British Columbia in 1990. This is up significantly from 25 males in 10 areas last year, and 12 in 7 areas in 1988. Male moths were caught near Parksville (2) for the fourth consecutive year, in West Vancouver (3), Vancouver, at Fraser Street (2), and the Saanich Peninsula (96), for the second consecutive year. With the detection of this introduction site an additional 12 females, 14 pupal cases and 37 egg masses were collected. New catches were made at Victoria (2), Colwood (3), Campbell River (2), Comox (1), Lantzville (1), Nanoose Bay (1), Cameron Lake, west of Coombs (1), North Vancouver (2), Coquitlam (1), Rosedale (2), Roberts Creek, Sechelt (1), and in Yoho National Park (1). None were caught near Kelowna where high trap catches (194 males) and numerous egg masses (30), prompted aerial and ground applications of B.t. in 1988 in an apparently successful eradication effort.

The only aerial (85 ha) and ground (7.5 ha) applications of Bacillus thuringiensis for gypsy moth in 1990 were at Parksville, where subsequent trapping captured only 2 males outside the spray block.

The capture at Yoho National Park was in one of 350 traps set out by FIDS in 268 forested recreation areas in national and provincial parks, commercial campgrounds, or near military bases.

European Pine Shoot Moth

Surveys of interior native and exotic pines were discontinued following testing of pheromone baits in sticky traps at 5 interior and 6 coastal sites in 1988 to determine the status of the shoot moth since provincial quarantine regulations lapsed in 1981. Survey results indicated that the shoot moth is established in localized urban areas including Victoria to Courtenay, the lower mainland, and the Okanagan Valley. However, the areas have not increased in number and there is no evidence of shot moth populations in native pines.

Balsam Woolly Adelgid

Adelgid populations were found on grand fir on Hornby Island, north of the quarantine zone in southwestern British Columbia. However, populations were too low to cause any obvious damage. This was the first record outside the zone since 1987, when populations were found on West Thurlow Island, northeast of Campbell River. There was no evidence of the adelgid on grand fir in the Nelson Region, along the International border north of Idaho where pockets of infested fir have increased dramatically.

Tent Caterpillars

Defoliation of trees and shrubs by forest tent caterpillar was widespread near Prince George and McBride, in the Peace River area, in parts of the Cariboo Region, in the East Kootenay, and in the northern part of the Kamloops Forest Region. More than 355 locations covering 205 800 ha were defoliated, some for the seventh consecutive year.

Northwest of Prince George, increased populations defoliated trembling aspen in more than 125 infestations over 153 600 ha, up 30% from 1989. In the Peace River, defoliation over 35 600 ha in 80 separate areas, was up sevenfold from 1989. Near McBride the area of defoliated aspen increased to over 4450 ha, up from 260 ha in 1989 the first year of the infestation. Defoliation in the Cariboo Region increased 30% to over 4650 ha in 62 pockets. In the Nelson Region defoliation was down 57% to 4300 ha in 19 pockets in the East Kootenay. There was a threefold expansion in the Kamloops Region to 3200 ha in 26 areas in the North Thompson River Valley.

Generally severe defoliation of trembling aspen, cottonwood and other deciduous trees and shrubs is forecast to continue in most recently infested stands near Prince George, based on egg samples from 15 areas. An average of 17 new egg masses per tree (range 2-49), were counted at 12 sites near Prince George, down from an average of 38 in 1989. Counts greater than 10 masses per tree usually result in severe defoliation. Defoliation is forecast to be only trace or light in the Peace River, near McBride, and in the East Kootenay where there were two or less egg masses per sample. Larval parasitism at seven sites in two regions averaged less than 5%, too low to significantly reduce populations.

Increased northern tent caterpillar populations in the Skeena River Valley in the western part of the Prince Rupert Region defoliated mostly cottonwood over 3200 ha, up from 150 ha in 1989. Defoliation was mostly light and moderate and confined to valley bottom stands, but fruit trees in Terrace were defoliated. Based on egg mass surveys at nine locations, defoliation is forecast to be mostly severe and widespread in 1991.

Large aspen tortrix

Defoliation of trembling aspen was widespread in the Prince George Region and Yukon Territory, in some areas for the third consecutive year. Defoliation in 64 separate areas in the Prince George Forest Region totalled 16 465 ha, up from 10 000 ha in 1989. Most stands were severely defoliated, from Mackenzie to Fort Ware and along the Alaska Highway from Fort St. John to Pink Mountain and west of Fort Nelson at Steamboat Mountain. In the Yukon Territory, defoliation was widespread over 9100 ha along the Alaska Highway west to Takhini Hot Springs and north to Lake Laberge. Defoliation was severe over about half the area and moderate and light over the remainder.

Previous outbreaks usually collapsed due to parasitism after three years. Larval parasitism mostly by *Glypta conflictanae* was 76% in 1989, and pupal parasitism 21%; these levels are expected to increase and reduce populations in three-year-old infestations. Remoteness precluded assessments of populations in new outbreaks in the Prince George Region.

Cone and Seed Pests

Assessments of the incidence and intensity of cone and seed insects and diseases in natural forests in the Pacific Region, was de-emphasized in 1989. This was due in part to the conclusion of the research study at Pacific Forestry Centre and some seed orchard pest assessments done by the B.C. Ministry of Forests.

In 1990, 11 coastal seed orchards were surveyed. Cooley spruce gall adelgid lightly and occasionally severely infested all the Douglas-fir in five of nine orchards, and 5% of the spruce at two orchards. Balsam woolly adelgid was common on amabalis fir in four orchards, and balsam twig aphid deformed needles and twigs on about 15% of the true firs at two orchards. Green spruce aphid infested up to 70% of the trees at three of four orchards. There was no evidence of significant damage to trees at three interior seed orchards. A gall midge in yellow cedar cones declined due to parasitism of more than 75%. This followed three consecutive years of severe damage in two orchards. Hemlock woolly adelgids declined to endemic levels, lightly infesting western hemlock at one orchard.

EXPERIMENTAL CONTROL PROJECTS

Bark Beetles

Work was concentrated in two main areas: (a) hazard rating for mountain pine beetle, and (b) the effect of of semiochemical treatments on attack behavior of the mountain pine beetle.

a) The second (and final) assessment of the 150 hazard plots was completed. This data was analyzed and a preliminary hazard rating system was developed based on stand and site factors and beetle population size and proximity to the subject stand. In limited field tests the rating system performed reliably. A manuscript is in final stages of preparation.

   Data analysis was completed on dispersal of mountain pine beetles marked with fluorescent powder. In general, numbers of beetles trapped at baited trap trees declined sharply to a point 60-80 m distant from the release site and then leveled off. Beetles tended to disperse upwind and downwind from the release site. It was estimated that ca. 2% of the beetles dispersed above the forest canopy.

b) A cooperative study with Phero Tech Inc., Vancouver, B.C. was conducted to test the effects of an anti-aggregating pheromone verbenone and of exobrevicomin on attack behavior of the mountain pine beetle. Results indicate that verbenone, alone and in the presence of exo-brevicomin, significantly reduced attack by mountain pine beetle. A manuscript of the results is in preparation.

The highlight of consultative advice/service activity is the participation by Dr. Safranyik on a combined B.C. Ministry of Forests, Forest Industry, PFC Task Force to develop strategies, tactics and an operational plan to reduce losses from the mountain pine beetle.

Pinewood Nematode - Research

Research on the pinewood nematode at Pacific Forestry Centre involves host susceptibility testing of North American and European seedlings, artificial infestation of log bolts to evaluate nematode survival and potential vectors, and development of a technique to infest lumber for testing of heat treatment as an alternative to K.D.

British Seedling Inoculations - three trials have been completed:

a) European larch (EL) ambient temps. (15/21°C)
b) European larch (EL) elevated temps. (25/30°C)
c) Norway spruce (NS) elevated temps. (25/30°C)

For each trial, 75 seedlings were inoculated with 4 nematode isolates and a nematode-free control (i.e. 15 seedlings per treatment). The nematodes used were Canada-m from British Columbia; Canada-r from Ontario; *B. xylophilus* from Japan and a French isolate. Seedlings were inoculated with 2000 nematodes each and the trials lasted approximately 100 days. No trees died in the EL ambient temp. trial and no PWN was recovered when the seedlings were subsampled at the end of the experiment. In the EL elevated temp. trial, 57 seedlings died (none of the controls) and again no PWN was recovered from the remaining inoculated seedlings. Three NS seedlings died (BC isolate) and 6 had PWN in low numbers when subsampled at the end of the trial.

There are still 5 possible trials to be carried out: Norway spruce, Corsican pine and Scots pine at ambient temperatures, and Corsican pine and Scots pine at elevated temperatures.

The lumber inoculation trial for the proposed Forintek study involves boards of 8 lodgepole pine + 2 Doug fir with a BC isolate; 8 lodgepole pine + 2 Doug fir with a Ont isolate, and 4 lodgepole pine + 1 Doug fir with a control. All boards were inoculated with 20,000 nematodes (except controls) and are being stored in plastic bags at 25°C. Sampling will begin in mid-November and continue at 3-week intervals.

In a further study of the potential vectors of pinewood nematode, 96 insect-infested, 60 cm logs (32 white spruce, 32 Douglas-fir and 32 lodgepole pine) were collected from throughout B.C. by the FIDS rangers from PFC. Once checked to ensure that no PWN were present in these logs, they were artificially infested with PWN from three locations (Canadian "r" from St. Williams, Ontario; Canadian "m" from Clinton, B.C.; and *B. xylophilus* from Shimane Prefectur, Japan), along with a control treatment, containing no PWN.

The nematode population within each log was monitored at approximately 25-day intervals. PWN populations within the logs were low (PWN established in only 33% of the logs), perhaps due to the logs being very dry and in some cases containing rot. Other species of nematodes were also found in the logs during extractions.

Of the 2259 insects (17 species) that emerged from the caged logs, 1762 (78%) were assessed for PWN. None carried PWN. (PWN were extracted from one *Monochamus scutellatus* that had had PWN inoculated directly onto its pupal surface, whilst still in the log, thus showing that the technique for extracting the nematodes worked).

Results from artificial inoculations of western hemlock could aid a decision by the EEC for exemption status for hemlock, under new Canada-EEC trade restrictions. Thirty 1-m logs of western hemlock were collected from Jordan River, Vancouver Island. Ten were from healthy trees, ten from dying trees and ten from long dead, fallen trees. The logs were checked to ensure they contained no PWN, and then five of each treatment were artificially infested with PWN from B.C. PWN appears to be surviving only in three out of five of the logs from living trees. Other nematode species are commonly found in these logs. Periodic sampling will continue to establish the longevity of the nematodes as the wood cells die.

Winter moth

Populations of this accidentally introduced pest of deciduous trees, mainly Garry oak and other shade trees, shrubs and fruit trees, increased slightly in 1990. Winter moth populations declined mainly as the result of the introduction between 1979 and 1982 of two exotic parasitoids: the parasitic fly, *Cyzenis albicans*, and the parasitic wasp, *Agrypon flaveolatum*. These two introduced parasitoids, assisted by other mortality agents including unfavorable weather, predators, asynchrony between budburst and larval emergence, brought the winter moth under control for the past four years. However, there was a slight resurgence of the pest in some parts in the greater Victoria area causing some defoliation in association with the Bruce spanworm, *Operophtera bruceata*, and the western winter moth, *Erannis tiliaria vancouverensis*.

Preliminary results based on x-raying subsamples of winter moth pupae show a combined parasitism by the two introduced species about 50%. This is a slight increase over last year; parasitism by the wasp almost doubled reaching just over 10%.

The winter moth has been reported from the blueberry-growing areas of the Lower Fraser Valley. On the lower mainland, defoliation of deciduous trees by winter moth and Bruce spanworm moth continued for the second consecutive year and occurred over a larger area than 1989, while defoliation by the western winter moth continued for the fourth consecutive year.

Two pesticides, the pyrethroid deltamethrin (Decis) and *Bacillus thuringiensis* var. *kurstaki* (*B.t.k.*) was tested (by D.H. Sheppard, J.H. Myers, S. Fitzpatrick and H. Gerber) for the control of the winter moth in blueberries. The pyrethroid was effective and the *B.t.k.* was not effective in controlling the winter moth in blueberries. Decis is already registered for winter moth control.

Blackheaded budworm - Bacillus thuringiensis var. kurstaki trials

At present we do not have any product registered for the control of blackheaded budworm in Canada.

In 1989 Dipel 176 (a Btk product registered both in Canada and the US against the spruce budworm) was field tested in cooperation with BCMF, Abbott Laboratories, Forestry Canada and Western Forest Products Ltd. Dipel 176 was applied at 30 BIU/ha at the rate of 1.8L/ha, the recommended dosage for spruce budworm, by a fixed-wing aircraft equipped with micronair atomizers (AU 4000). The results were disappointing; larval reduction was about 52% after correction for natural mortality.

In 1990 we enlarged the test, increased dosage and applied three products. The cooperators were Abbott and Novo Laboratories, Chemagro Ltd., BCMF, Forestry Canada and Western Forest Products Ltd. Each product was applied to three plots (replicates) varying from about 20- to 30-ha each. The spray aircraft was the same as before and the blackheaded budworm was in 'free' feeding larval stage at the time of application. The Btk application was evaluated by:

a) measuring spray deposit on the needles on the sample trees (from the 9 treated and from the 2 check plots closest to the treated plots)
b) bioassay: rearing larvae for 3 days on foliage collected from these sample trees, then for 3 additional days on untreated foliage.
c) by taking population counts before treatment, 1, 2 and 3 weeks after application and calculation of population reduction using the modified Abbott's formula
d) egg counts - still in progress

The preliminary results are summarized below:

Spray deposit per needle was relatively good (western hemlock has short needles about 5- to 6-mm long). As expected, the spray deposit per needle appeared to be related to the emitted spray volume. No spray deposit was detected in the two check plots closest to the treated plots.

Weather conditions were favorable during spray application. Although blackheaded budworm population started to decline in 1990, good population reduction was obtained by all three products. Dipel 176 at 2.4L/ha gave the highest population reduction with about 97%, followed by Futura XLV-HP at 1.2L/ha with 83% and Forey 48B at 3.9L/ha with 69%. These show some interesting trends. Futura XLV-HP almost gave the same population reduction as Dipel 176 even though it was applied at half the rate. One would have expected higher population reduction from Foray 48B at 50 BIU/ha applied at 3.9L/ha. However, one of the plots, plot 4, received poor spray deposit and the lower population reduction in this partly missed plot may account for the lower reduction. In the other two Foray plots where spray deposit was good, population reduction was comparable to those in the other treatments.

PRELIMINARY TABLE OF THE RESULTS OF TESTING THREE BTK PRODUCTS AT HOLBERG,B.C.,1990

PLOT No.	TREATMENT	No. OF TREES [a] EXAM'D	MEAN No. DROPLETS/ NEEDLE	S.E.	FEEDING BIOASSAY NO. LARVAE REARED	(% killed by B.t.k.) 3 day	6 day	Total	VALUES FOR POPULATION REDUCTIONS SAS	CALCULATED BY PANNEKOEK
7	FUTURA XLV-HP	30	0.29	+ 0.057	233	-	69.2	69.2	71.688 [c]	
8	40 BIU/ha.	30	0.20	+ 0.026	227	0.0	64.1	58.1	94.596	
9	1.2L/ha.	30	0.40	+ 0.063	226	52.9	72.7	57.8	88.401	
AVERAGE	Plots 7-9	90	0.30	+ 0.030	686	47.4	67.6	62.1	83.200	82.000
1	DIPEL 176	30	0.42	+ 0.059	230	23.9	57.7	36.1	100.000	
2	40 BIU/ha.	30	0.60	+ 0.078	228	33.3	57.9	42.9	96.968	
3	2.4L/ha.	30	0.17	+ 0.028	232	48.4	75.0	55.8	67.099	
AVERAGE	Plots 1-3	90	0.40	+ 0.038	690	33.6	61.4	43.3	96.981	95.100
4	Foray 48B	30	0.27	+ 0.062	226	8.3	54.5	38.2	50.148	
5	50 BIU/ha.	30	1.00	+ 0.157	226	85.0	91.7	86.5	92.417	
6	3.9L/ha.	30	1.44	+ 0.138	227	64.1	100.0	70.5	100.000	
AVERAGE	Plots 4-6	90	0.90	+ 0.088	679	65.5	77.1	68.9	69.414	70.800
10	CONTROL [b]	15	0.00	+ 0.000	155	0.0	0.0	0.0		
11		20	0.00	+ 0.000	101	0.0	0.0	0.0		
AVERAGE	Plots 10-11	35	0.00	+ 0.000	256	0.0	0.0	0.0		

a 10 needles (5 from each of 2 shoots) were examined from each tree.

b These two control plots (10 and 11) were the closest (500m and 1km respectively) to the nearest treated plots.

c Values for Abbott's formula calculated 3 weeks after spray from total number of live larvae per square metre

Bioassay

In summary, Btk applications in the 40-50 BIU/ha dose range gave good population reduction in the Holberg area (northern end of Vancouver Island) and will probably give good population reduction elsewhere under favorable weather conditions.

Forest Nursery Survey and Research

The Pacific Forestry Centre's Nursery Pest Clinic has received 208 multi sample requests for disease diagnostics in 1990. The main disease problems encountered were root rots caused by *Fusarium* and *Pythium* and shoot blights caused by *Botrytis* and *Sirococcus*. *Fusarium* caused damping-off in the spring as well as root disease in the summer. *Pythium* root disease occurred in the summer as nursery personnel watered frequently to keep the seedlings cool. A cool, wet spring encouraged *Sirococcus strobilinus*. This fungus was found for the first time in nurseries on western hemlock and also in western hemlock seeds. *Botrytis* grey mould damaged seedling stock in early fall as the weather began to cool and become wet. Sensitivity trials indicated that many nurseries had strains of *Botrytis* which were resistant to some of the registered fungicides. Keithia blight (*Didymascella thujina*) was again found at several nurseries but was kept at very low levels with carefully monitored fungicide trials, mainly with Bayleton.

Because early detection and prevention of disease is critical in minimizing losses, the Pacific Forestry Centre participated in several joint trials. *Fusarium* was detected in samples of sand intended as a new and inexpensive seed covering. Attempts to clean the sand significantly reduced, but did not eliminate, the *Fusarium*. Trials, also in cooperation with the B.C. Ministry of Forests, indicated that standing water used during stratification could increase *Fusarium* spread and losses. Some improvement was obtained using running water, but losses varied with the initial levels of disease in the seedlot. Assays were done to assist the BCMF in registering a fungicide (Ridomil) for *Pythium* control. Because some isolates of *Botrytis* are resistant to fungicides, sensitivity tests were completed. This enabled nurseries to select the most effective fungicide to control their particular disease, reducing overall use of chemicals.

Mycoherbicide: Vegetation management research

The program at PFC was initiated in 1986 and has concentrated on defining the forest weed problem in British Columbia, discovery of fungi with mycoherbicide potential, and development of a few promising candidate fungi. Financial support has come from limited A-base funding, FRDA, and the Science and Technology Opportunities Fund. Staffing has increased from 1 P/Y in 1986 to 5 P/Ys in 1990, with valuable inputs from other staff members and cooperators. Several findings suggest the possibility of acceptable products with commercial potential. Numerous pathogenic and endophytic fungi have been cultured from forest weed species. Notice of intent to patent has been submitted for 4 potential mycoherbicides and several articles published. Inoculation trials on brush species with native pathogenic fungi have been established and preliminary results for two of these (hardwoods and thimbleberry) published. Laboratory studies are well advanced on the variability and some of the biochemical bases of pathogenicity of three promising candidate fungi, *Chondrostereum purpureum*, *Cylindrocarpon destructans*, and *Melanconis alni*. Studies on variability in pathogenicity of *C. purpureum* are nearing completion. Plant bioassays for detecting its phytotoxic metabolites have been developed.

Target weed species currently included in the mycoherbicide project are bigleaf maple, red alder, bluejoint grass, fireweed, salal, aspen, and thimbleberry. Vegetative cuttings of other *Populus* and hybrids are used as bioassay materials. Pathogenic fungi currently under investigation are *Chondrostereum purpureum*, a wound pathogen of most woody plants; *Cylindrocarpon destructans*, a root pathogen of thimbleberry and other plants; *Phyllosticta pyrolae* on salal foliage, *Melanconis* spp., *Nectria* sp. and *Hypoxylon* sp. causing cankers of alders; and *Septoria rubs*, a foliar pathogen of thimbleberry. Other pathogens of current interest are *Cercospora* sp. from *Ribes*; *Colletotrichum* sp. from raspberry; *Gnomonia* spp. from *Rubus* spp.; *Hainesia* sp. from thimbleberry; *Pollaccia radiosa* from aspen; *Verticillium* sp. from thimbleberry; and the raspberry leaf curl virus.

A major objective of the mycoherbicide project is to define candidate mycoherbicides amenable to accelerated commercial development. This will require a considerable body of knowledge on the pathogenicity, host range, variability, phytotoxic metabolites, potential methods of formulation and application, and foreseeable off-target effects of several weed pathogens. The combined efforts of several workers will include plant pathologists (pathogenicity, host range and variability of candidate pathogens), a biochemist/immunologist (pathogenesis related proteins, phytotoxic metabolites), a plant physiologist (phytotoxic metabolites, methods of formulation and application) and a biochemical geneticist (genetic fingerprinting of pathogenic strains, phytotoxin production).

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November 1990

SPRUCE BUDWORM CONDITIONS IN THE UNITED STATES
1990

EASTERN SPRUCE BUDWORM

LAKE STATES

Eastern spruce budworm populations have remained static since last year. A total of 198,000 acres were defoliated in northeastern Minnesota. Defoliation was identified as light to moderate with none listed in the heavy category. Trap catches for the area average approximately 250 moths/trap. In Michigan, approximately 2,500 acres of defoliation were reported and none for Wisconsin (See Table 1).

NORTHEAST

For the first time in this century, no defoliation was reported for the State of Maine or for Vermont, New Hampshire, or New York. Trap catches average less than one moth per trap. As there were no records kept for the period 1918-1945 we can only speculate for this period. However, tree girdling was practiced during this period in order to reduce defoliation at least in the State of Maine.

WESTERN SPRUCE BUDWORM

REGION 1 (NORTHERN REGION)

Western spruce budworm defoliation increased slightly in Region 1 during 1990. Results of the aerial detection survey show 1,485,000 acres of defoliation for 1990 compared to 1,208,000 acres in 1989 and 2,084,000 in 1988. The population decline in 1989 was due in large part to the extreme winter temperatures in January. This spring, however, populations appear to be recovering in certain areas. Most of the national forests had a decline in defoliation in 1990 with the exception of the Bitterroot and a few other forests.

In Montana, most of the areas showing an increase in defoliation in 1990 are the same ones that had severe mid-winter temperatures in 1989. The largest buildup occurred on the Helena and Lewis and Clark National Forests, and in the Garnet Mountains near Missoula. The Bitterroot National Forest has the largest increase.

Presented by Daniel R. Kucera, Staff Entomologist, Northeastern Area, State and Private Forestry, USDA Forest Service, Radnor, Pennsylvania at the Eighteenth Annual Forest Pest Control Forum, Ottawa, Ontario, November 20, 1990.

In 1990, no aerial application projects were conducted in the Northern Region and none are planned for 1991. Several Douglas-fir seed production areas on the Gallatin and Helena National Forests were treated using Acecap implants in 1990. For 1991, treatments are proposed for a seed tree cut area on both the Beaverhead and Deerlodge National Forests.

Pheromone baited traps were used at seven locations both in 1989 and 1990. From 15 to 22 traps were hung in each area. In 1990, larval density and egg mass counts were made in order to compare 1990 data to that of 1989. Trapping will continue in 1991.

REGION 2 (ROCKY MOUNTAIN REGION)

Defoliation is again light. No aerial surveys were conducted this year.

REGION 3 (SOUTHWESTERN REGION)

Western spruce budworm defoliation increased significantly throughout the Region (from 90,363 acres in 1989 to 311,032 acres in 1990). Intensity of defoliation was categorized as light, 77,162 acres, moderate, 136,001 acres, and heavy 97,869 acres. Most of the defoliation occurred on the Carson, Santa Fe, and Kaibab National Forests and on State and private lands. In 1991, both the area of defoliation and the intensity of defoliation is expected to increase. An analysis is currently underway to determine the need for ground application in up to 13 campground areas. Should this infestation continue to increase aerial application may become necessary in 1992.

REGION 4 (INTERMOUNTAIN REGION)

After a four year break in defoliation, the western spruce budworm was again detected in the Region. Defoliation occurred on the Challis and Salmon National Forests in southern Idaho. Approximately 42,000 acres were classified in the light to moderate defoliation category.

REGION 5 (PACIFIC SOUTHWEST REGION)

Defoliators are not a problem in California forests. The last significant budworm defoliation occurred in 1985.

REGION 6 (PACIFIC NORTHWEST REGION)

In 1990, approximately 2,270,000 acres of defoliation has been reported thus far and surveys are continuing. Defoliation increased from 1.4 million acres in 1989 to 2 million in 1990 in Oregon and from 230,000 acres in Washington State to 270,000 acres. In Oregon, most of the defoliation is in the northeastern part of the State.

For a block to be considered for treatment, prespray counts must average over 6 larvae per 45 cm mid-crown branch tip. In the 71,000 acres treated on the Yakima Indian Reservation in 1990, larval counts exceeded 20 larvae per 45 cm branch tip. Post spray counts averaged less than 3 per 45 cm branch tip. Thuricide 48LV was applied at the rate of 16 BIU per acre. Cost of application averaged $25.35 per acre.

For 1991, early projections indicate a potential project of 80,000 acres on the Umatilla National Forest in northeastern Oregon.

REGION 10 (ALASKA REGION)

After a long lull, spruce budworm populations were high, especially in white spruce stands in the interior of Alaska. Severe impacts occurred when larvae dropped off older trees onto two year old planted stock causing defoliation of current year's needles. In addition, seed and cone production was significantly reduced.

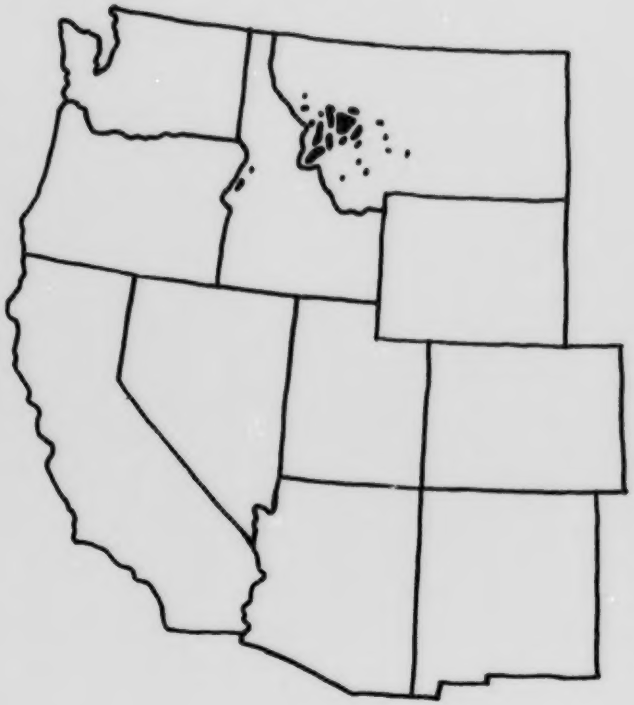
Table 1. Estimated Defoliation by Spruce Budworm in 1988, 1989, and 1990

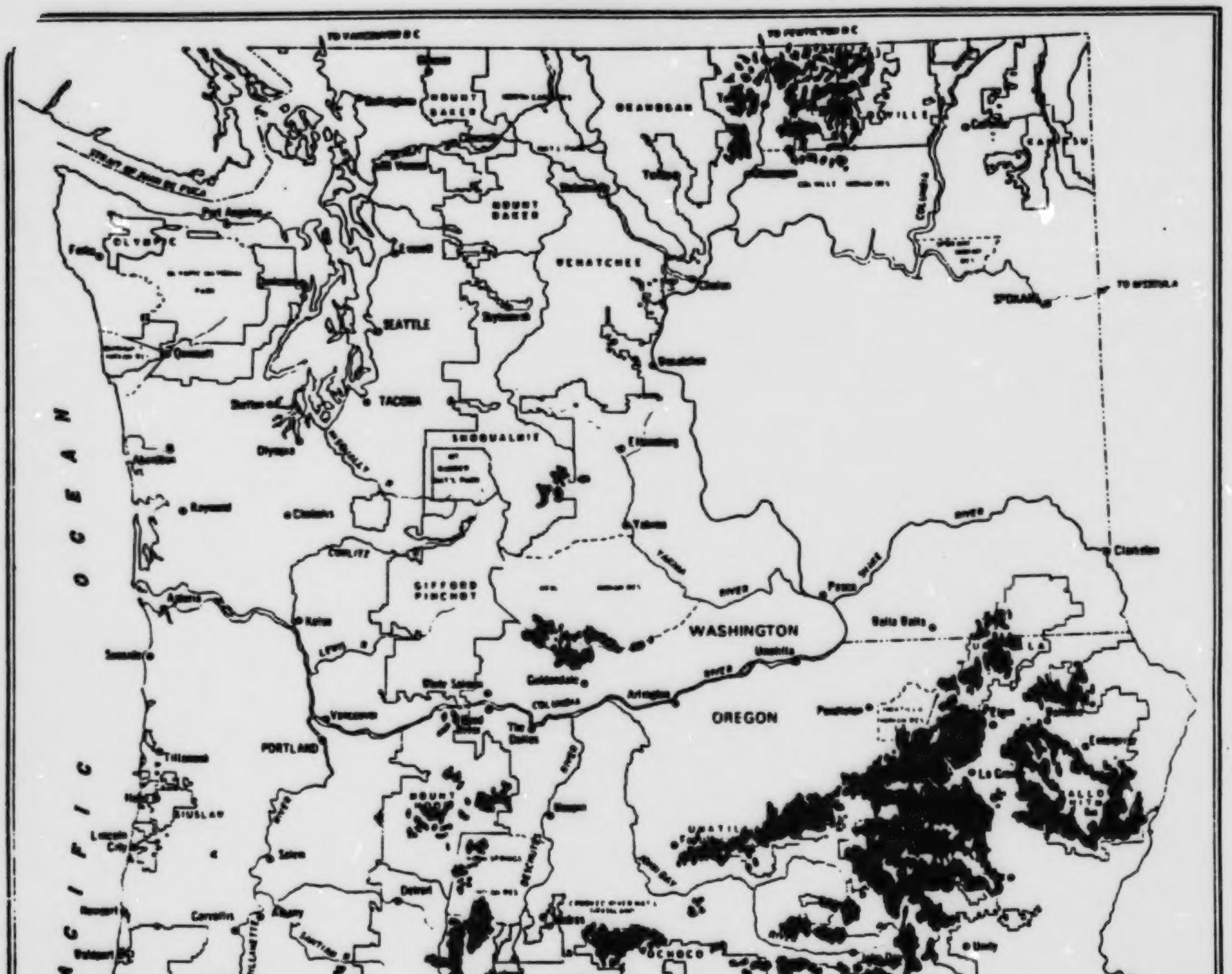
REGION/STATE	AREA DEFOLIATED 1988 (Acres)	AREA DEFOLIATED 1989 (Acres)	AREA DEFOLIATED 1990 (Acres)
Eastern Spruce Budworm			
Lake States			
Michigan	0	0	2,500
Minnesota	200,000	140,000	198,000
Wisconsin	0	0	
Northeast			
New Hampshire	0	0	0
New York	0	0	0
Maine	65,000	5,000	0
Vermont	0	0	0
Subtotal	265,000	145,000	200,500
Western Spruce Budworm			
R-1	2,018,779	1,201,273	1,485,000
R-2	482,800	52,000	0
R-3	483,578	90,363	311,032
R-4	42,300	10,588	42,000
R-5	19,768	0	0
R-6	2,762,540	2,000,000	2,230,000
R-10	0	0	0[1]
Subtotal	5,809,765	3,354,224	4,068,032
Total	6,074,765	3,499,224	4,268,532

1/ Although defoliation has been noticed, survey data is not available at this time.

REGION 1

SBW 1990




PACIFIC OCEAN
WASHINGTON
OREGON
SEATTLE
TACOMA
PORTLAND
GIFFORD PINCHOT
WENATCHEE
OKANOGAN
SNOQUALMIE
OLYMPIC
MOUNT BAKER
MOUNT HOOD
SIUSLAW
WILLAMETTE
DESCHUTES
OCHOCO
UMPQUA
WINEMA
FREMONT
SISKIYOU
ROGUE RIVER
SPOKANE
RIVER

Western Spruce Budworm

Defoliation 1990

GYPSY MOTH STATUS - USA

INTRODUCTION

Gypsy moth populations and defoliation continued to expand throughout the Northeastern United States and central Michigan in 1990. Total defoliation was 7,297,962 acres, up from 2,995,559 acres in 1989 and 719,302 acres reported in 1988. Of the 7.29 million defoliated acres, 4,357,700 or 60 percent occurred in Pennsylvania. This is the largest amount of defoliation to ever occur in Pennsylvania. Gypsy moth populations continued to expand into new areas of Michigan, Ohio, Virginia, West Virginia, and Wisconsin in 1990. (Table 1) In northeastern Ohio, the leading edge is over 300 miles long (from Toledo eastward and south to Wheeling, WV).

In 1990, over 1.5 million acres, a record amount of cooperative State and Federal suppression, were aerially sprayed to protect forested communities, recreation areas, parks, and high value forests from gypsy moth caused defoliation. This is nearly twice that treated in 1989. Private landowners may have treated another one million acres. Approximately 56 percent of the acreage was treated with various formulations of Bacillus thuringiensis (B.t.), 43 percent with diflubenzuron (Dimilin), and less than one percent with either Disparlure flakes or Gypchek. (Table 2)

Early suppression estimates for 1991 indicate that between one and two million acres will be treated with large state suppression projects planned for Maryland, Michigan, Pennsylvania, Virginia, and West Virginia. National Forest and other Federal suppression will total 60 thousand acres.

LAKE STATES

This past year, the Wisconsin Department of Natural Resources, in cooperation with Animal Plant Health and Inspection Service (APHIS) treated 550 acres as part of an eradication effort. In spite of this, moth catches have increased in 1990. Early projections are that Wisconsin will treat up to 30,000 acres in 1991.

In Michigan, gypsy moth caused significant defoliation in 25 counties this year. Enclosed is a map of defoliated areas. A total of 140,876 acres were treated in 1990. Areas treated with B.t. had 6 - 30 percent defoliation, while unsprayed areas ranged from 50 - 65 percent. The major objective of the aerial spray program was to reduce gypsy moth caterpillar nuisance to homeowners and to prevent defoliation greater than 40 percent. Target objectives were met.

Midland County, Michigan began a tree mortality survey this year. Thus far, untreated stands are averaging 13 percent mortality versus treated stands with only three percent mortality.

NEW ENGLAND STATES

Gypsy moth defoliation increased in all States except Rhode Island and New York. It is uncertain what will happen in 1991 because of a widespread fungus disease, *Entomophaga maimaiga*. In some areas, the fungus has definitely reduced egg mass density levels.

The State of Vermont and the Green Mountain National Forest cooperated on a 12,000 acre suppression project this year. Foray was applied at the rate of 64 oz./acre, 24 BIU undiluted. Both foliage protection and egg mass reduction were excellent. The State and the National Forest used the incident command system, to implement the project.

In western New York, the Seneca Nation treated approximately 2,000 acres with B t. (Dipel 8AF) applied twice. The material was applied undiluted (32 oz./acre) at 16 BIU/acre.

For 1991, projects are anticipated in Maine, Massachusetts, Vermont, and in New York (Seneca Nation).

REGION 8 (SOUTHERN STATES)

In the southern United States, a total of 234,688 acres were treated for gypsy moth (covering all ownerships). Of this, 19,961 acres were on National Forest and other Federal lands. Diflubenzuron (55 percent), B.t. (44 percent), and Gypchek and Disparlure (one percent) were the insecticides of choice.

In addition, North Carolina treated 4,200 acres and Tennessee treated 200 acres in separate eradication projects.

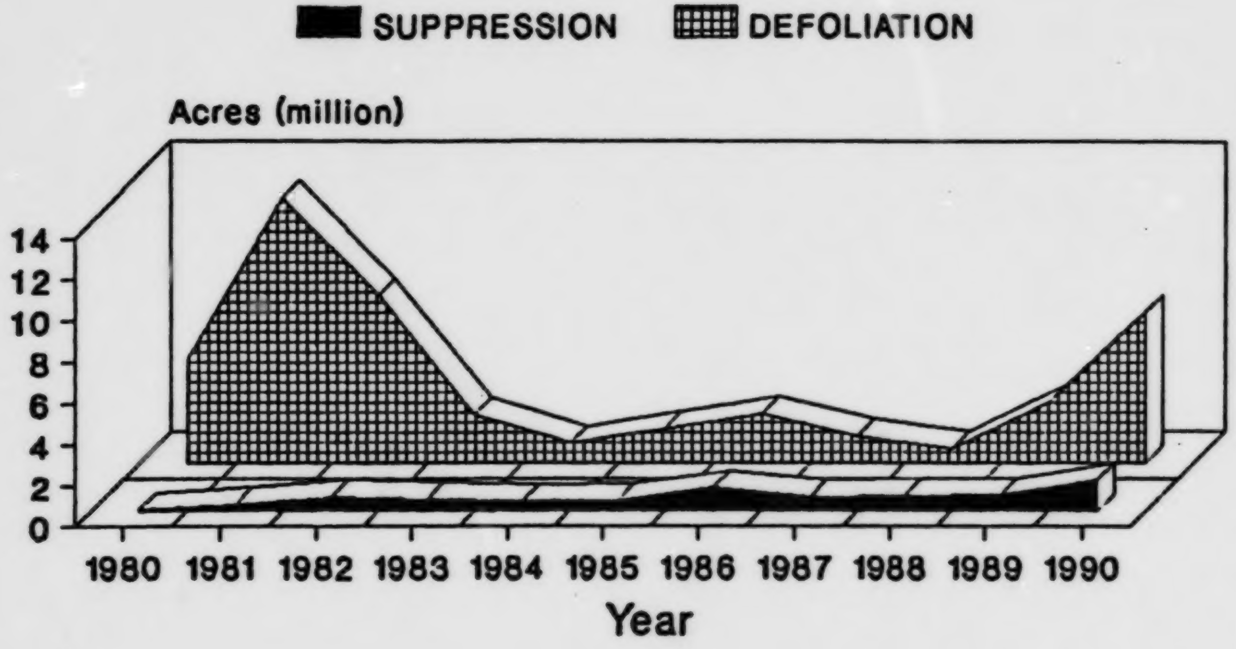
WESTERN STATES

REGION 1 (NORTHERN REGION)

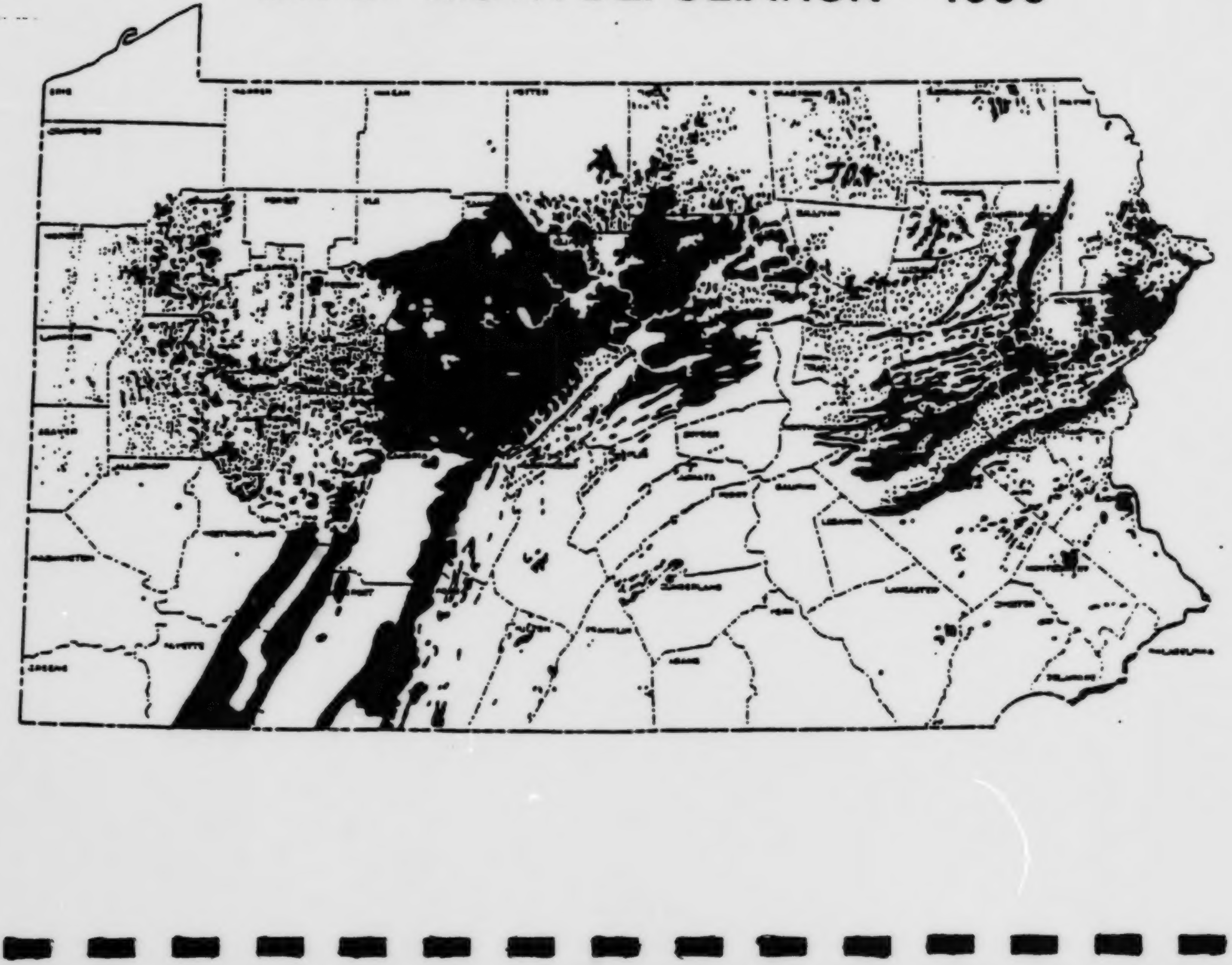
The Northern Region also participated in an eradication program for the second year. Two separate areas (the same as those treated in 1989) Coeur d'Alene and Sand Point, Idaho were treated with three applications of *B t*. A total of 1,060 acres were treated. The treatment was considered a success as no moths were trapped in the area. The only positive catches in Idaho were in Dover, approximately two miles from the treatment site.

Other areas trapped in the Northern Region included 13 National Forests, 3 National Parks, U.S. Army Corps of Engineers lands, U.S. Fish and Wildlife lands and that of the Bureau of Indian Affairs. The only two positive catches were in Yellowstone and Theodore Roosevelt Park.

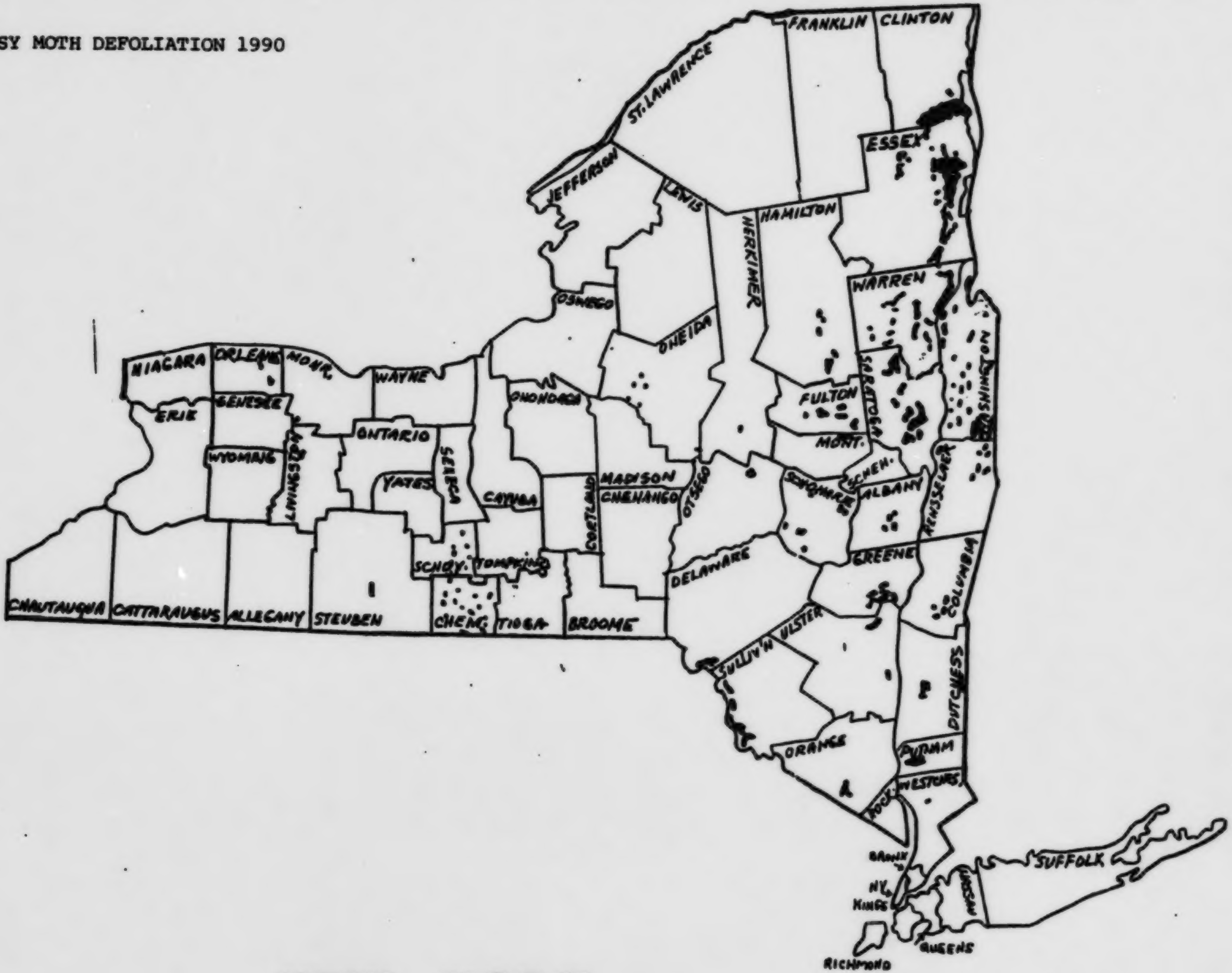
GYPSY MOTH
DEFOLIATION AND SUPPRESSION
1980-1990



GYPSY MOTH DEFOLIATION - 1990

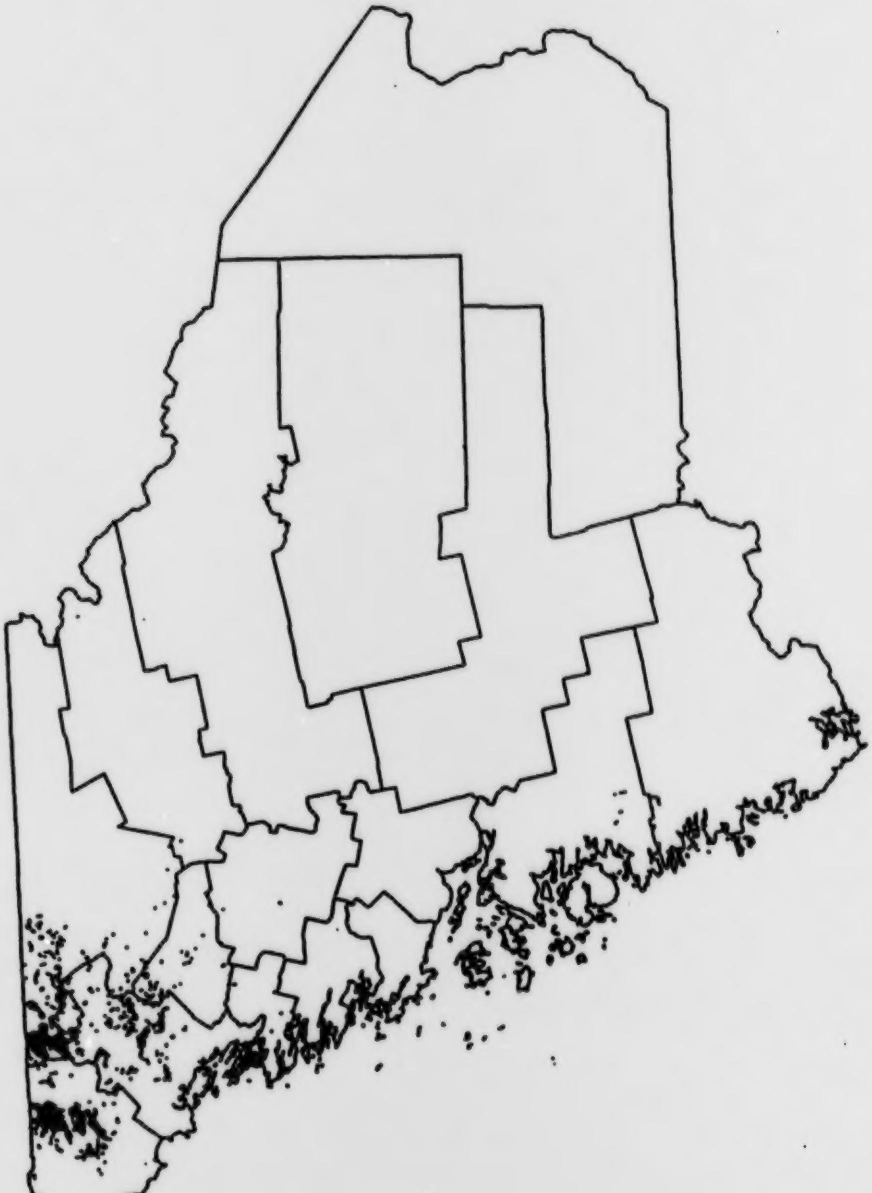


GYPSY MOTH DEFOLIATION 1990

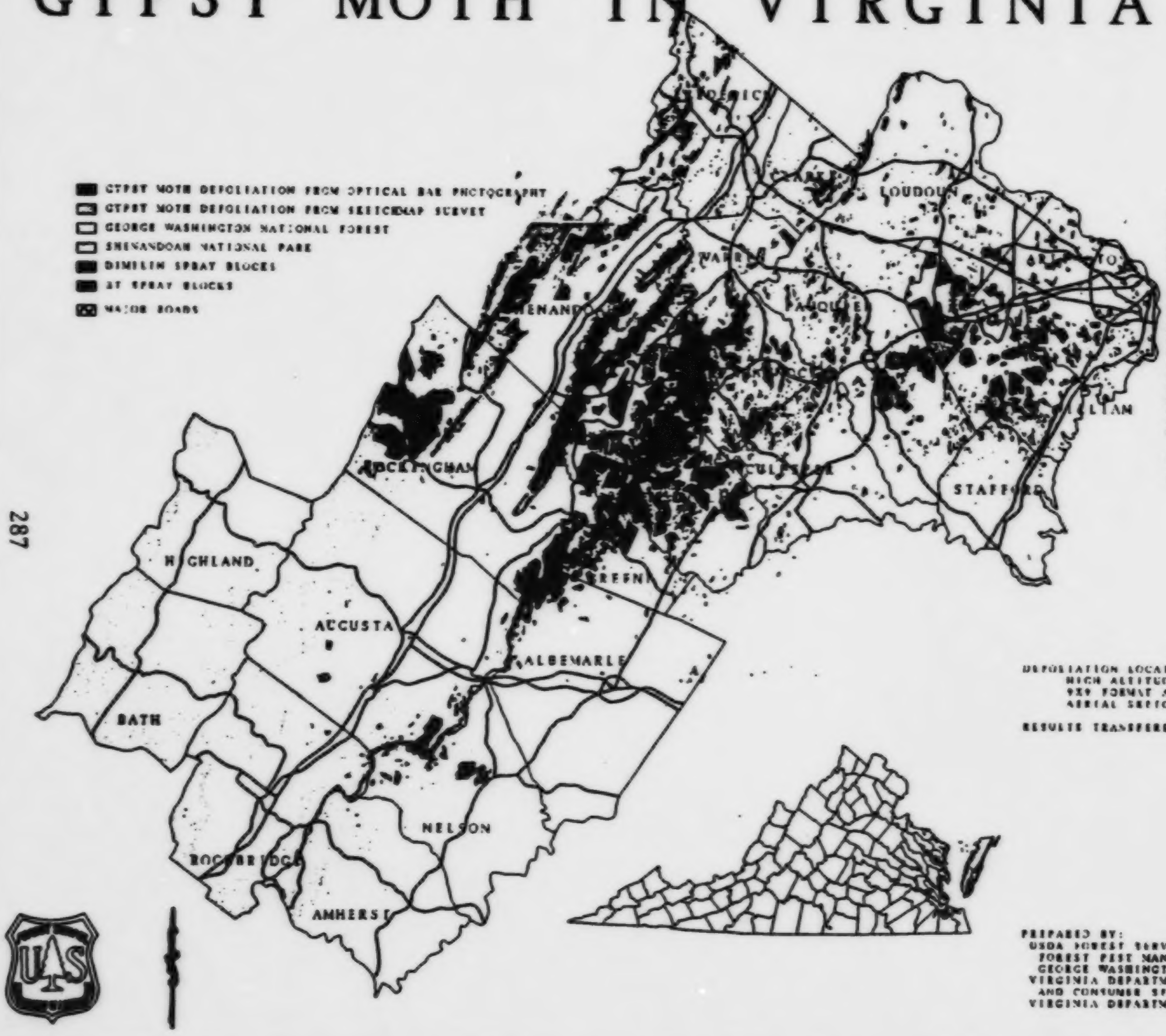

FRANKLIN
CLINTON
ST. LAWRENCE
ESSEX
JEFFERSON
LEWIS
HAMILTON
HERKIMER
WARREN
WASHINGTON
OSWEGO
ONEIDA
SARATOGA
FULTON
MONT.
NIAGARA
ORLEANS
MONR.
WAYNE
ONONDAGA
GENESEE
ERIE
ONTARIO
SENECA
WYOMING
LIVINGSTON
YATES
CAYUGA
MADISON
CHENANGO
CORTLAND
OTSEGO
SCHOHARIE
SCHEN.
ALBANY
RENSSELAER
GREENE
COLUMBIA
DELAWARE
SCHUY.
TOMPKINS
CHAUTAUQUA
CATTARAUGUS
ALLEGANY
STEUBEN
CHEM.
TIOGA
BROOME
SULLIV'N
ULSTER
DUTCHESS
ORANGE
PUTNAM
ROCK.
WESTCHES.
BRONX
NY
KINGS
RICHMOND
QUEENS
NASSAU
SUFFOLK

NEW YORK

1990
GYPSY MOTH DEFOLIATION IN MAINE



GYPSY MOTH IN VIRGINIA, 1990


GYPSY MOTH DEFOLIATION FROM OPTICAL BAR PHOTOGRAPHY
GYPSY MOTH DEFOLIATION FROM SKETCHMAP SURVEY
GEORGE WASHINGTON NATIONAL FOREST
SHENANDOAH NATIONAL PARK
DIMILIN SPRAY BLOCKS
BT SPRAY BLOCKS
MAJOR ROADS
FREDERICK
CLARKE
LOUDOUN
WARREN
FAUQUIER
SHENANDOAH
ARLINGTON
PRINCE WILLIAM
ROCKINGHAM
CULPEPER
STAFFORD
HIGHLAND
GREENE
AUGUSTA
ALBEMARLE
BATH
NELSON
ROCKBRIDGE
AMHERST

COUNTY	ACRES (x1000) DEFOLIATED
ALBEMARLE	15
AMHERST	1
AUGUSTA	11
CLARKE	6
CULPEPER	12
FAIRFAX	9
FAUQUIER	70
FREDERICK	16
GREENE	23
LOUDOUN	4
MADISON	74
NELSON	10
PAGE	92
PRINCE WILLIAM	9
RAPPAHANNOCK	63
ROCKBRIDGE	1
ROCKINGHAM	120
SHENANDOAH	78
STAFFORD	3
WARREN	14
ALL OTHER COUNTIES	1
TOTAL DEFOLIATION IN VA.	591

DEFOLIATION LOCATION OBTAINED FROM:
HIGH ALTITUDE OPTICAL BAR AERIAL PHOTOGRAPHY
9X9 FORMAT AERIAL PHOTOGRAPHY
AERIAL SKETCHMAP SURVEYS

RESULTS TRANSFERRED TO AND DIGITIZED FROM 1:24,000 USGS TOPO MAPS

PREPARED BY:
USDA FOREST SERVICE
FOREST PEST MANAGEMENT, REGION 8
GEORGE WASHINGTON NATIONAL FOREST
VIRGINIA DEPARTMENT OF AGRICULTURE
AND CONSUMER SERVICES
VIRGINIA DEPARTMENT OF FORESTRY

REGION 2 (ROCKY MOUNTAINS)

In California, the State applied diflubenzuron from the ground to eradicate gypsy moth at a Bay-front apartment complex in Marin County. Four locations in the State will have intensified surveys for the remainder of 1990. At present, no treatment projects are scheduled for 1991.

Other States, such as Colorado, have concentrated on "trapping out" and appear to have been successful.

REGION 4 (INTERMOUNTAIN REGION)

For the second year in a row, eradication efforts aimed at eliminating the gypsy moth from Utah continued with 20,064 infested acres aerially treated with three applications of B.t. Areas treated were along the Wasatch Mountains from Bountiful south to Provo. Mass trapping is continuing. Between 20-25,000 acres are projected for treatment in 1991. However, moth catches are declining significantly from year to year.

This year, the U.S. Forest Service contracted with ESPRO, Inc. for the purchase of 2,000 acre-equivalents of Gypchek with future options of 10,000 acre treatments in 1991 and 20-30,000 acre treatments through 1995.

Forest Pest Management has also developed a National Spray Model advisory committee to further develop spray models. Jack Barry will be the chairman.

The U. S. Department of Agriculture has released Department Regulations which designates the USFS as the "lead agency" for activities dealing with the gypsy moth in order to avoid duplication and to provide maximum coordination. It also designates agency roles in gypsy moth management for the Animal and Plant Health Inspection Service (APHIS), the Agricultural Research Service (ARS), the Cooperative States Research Service (CSRS), and the Extension Service (ES).

OTHER DEFOLIATORS

DOUGLAS FIR TUSSOCK MOTH (DFTM)

REGION 4

Significant DFTM defoliation was detected on the Boise National Forest in southern Idaho and Wasatch-Cache National Forests in northern Utah. Most of the defoliation is in the moderate to heavy category. This is the first major outbreak since 1973.

REGION 6

Light defoliation in the Wallawa Mountains of northeast Oregon mixed with WSBW outbreak.

FOREST TENT CATERPILLAR

LAKE STATES

In 1990, Wisconsin had 379,000 acres of defoliation. Predictions are that populations will continue to decline. The estimated defoliation for 1991 is approximately 70,000 acres.

The major defoliator in Minnesota in 1990 was the forest tent caterpillar. Approximately 4.3 million acres had some level of defoliation.

In Michigan, over 806,000 acres were defoliated this year. However, for 1991 populations are expected to decline and defoliation is expected to be about 200,000 acres.

NEW ENGLAND

No forest tent caterpillar defoliation was reported by our State cooperators in 1990. However, based on previous outbreaks, things should change in 1991.

REGION 8

The forest tent caterpillar defoliated approximately 360,000 acres in Louisiana and Mississippi. Severity of damage ranged from large completely defoliated tracts in central Mississippi and south Louisiana to scattered single trees in central Louisiana. Major host species are tupelo gum, sweetgum, willow, water, and Nuttal oak.

BARK BEETLES

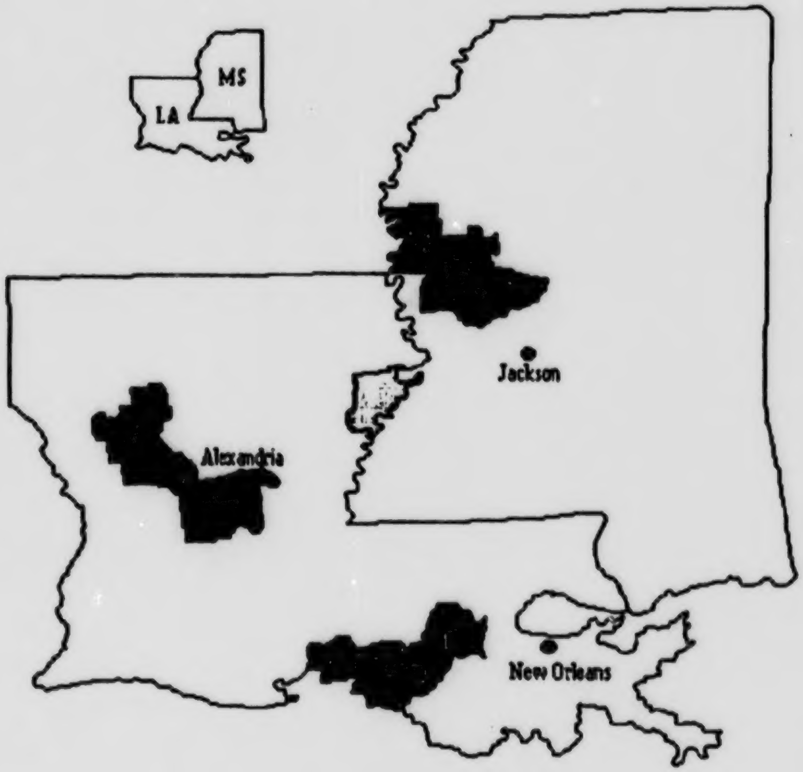
MOUNTAIN PINE BEETLE

REGION 1 (NORTHERN REGION)

Mountain pine beetle continued to be the most significant bark beetle pest in the Northern Region in 1990. Though the area of infestation continued a gradual decline, more than 400,000 acres of all pine hosts on all ownerships showed some level of tree killing. Infested acres totaled more than 2.4 million in the peak year of 1981. While infestation levels were less severe in most areas sampled, lodgepole pine stands on portions of the Kootenai and Lolo National Forests in northwest Montana experienced attacked trees

Forest Tent Caterpillar (Malacosoma disstria, Hbn.) Defoliation

Louisiana and Mississippi Counties Affected in 1990

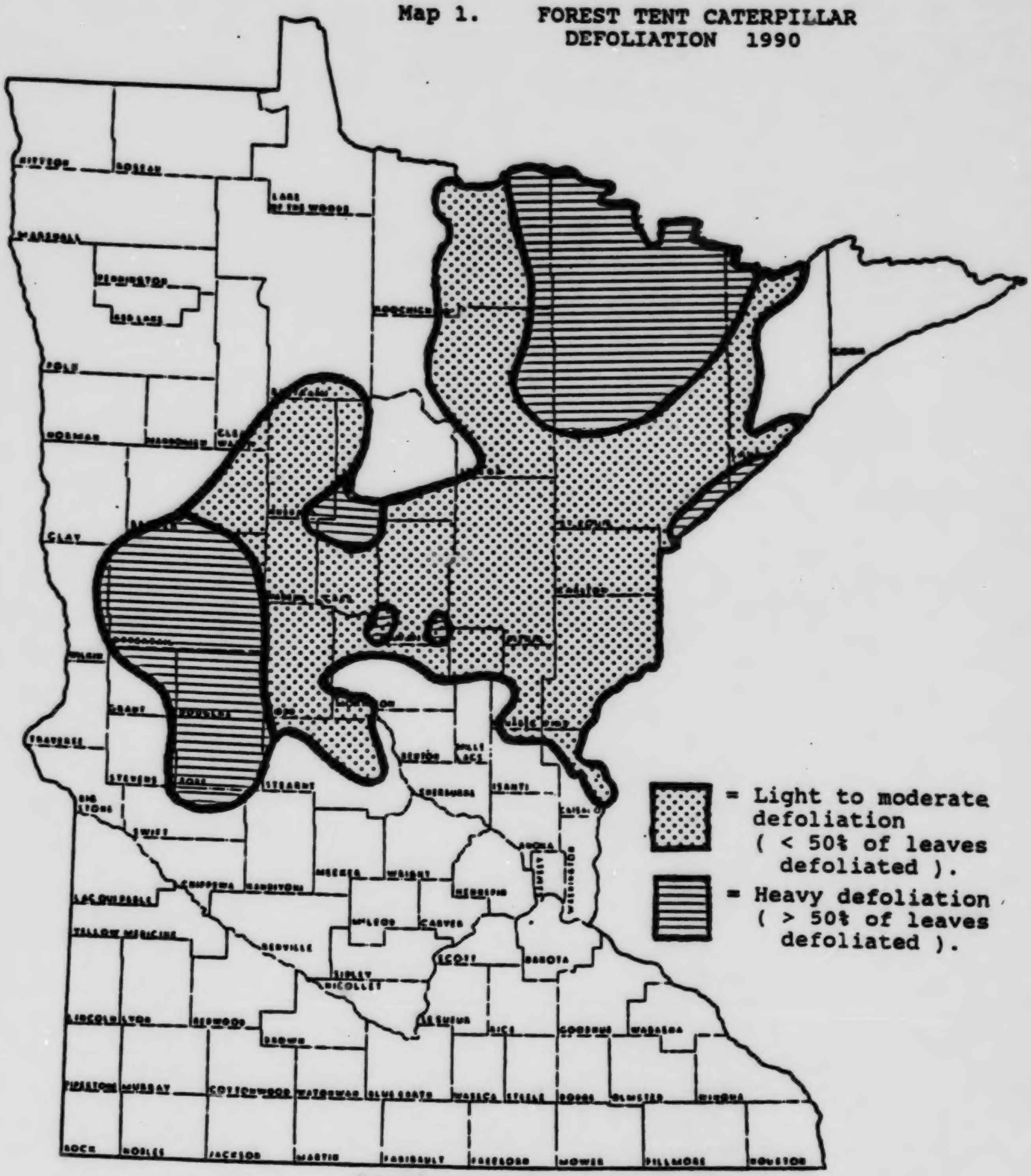


Ownership	Acres Defoliated Louisiana	Acres Defoliated Mississippi
State and Private	220,000	5,000
National Forest	20,000	30,000
Dept. of Interior	30,000	55,000
Total	270,000	90,000

Species Affected

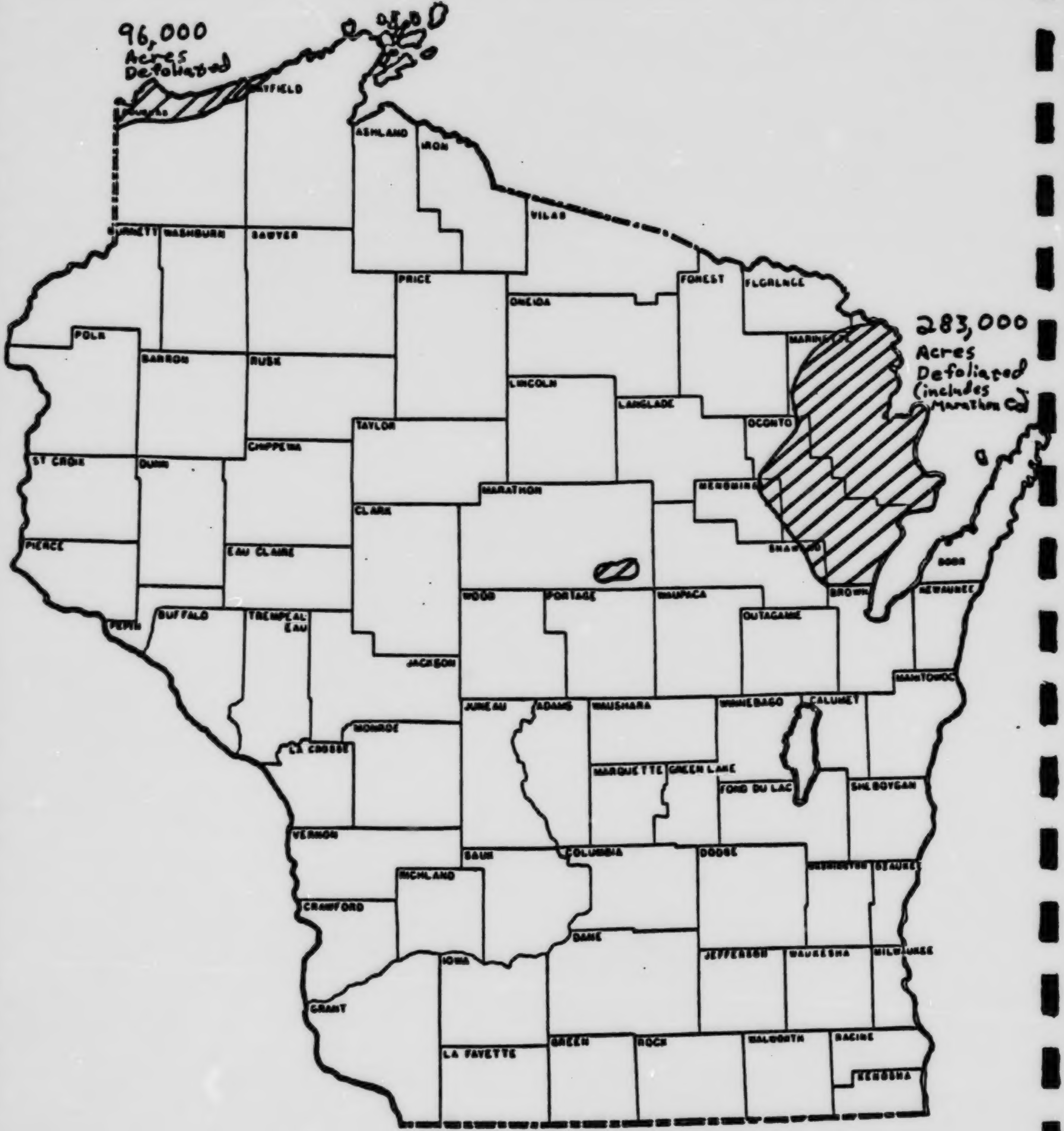
- ● - Tupelo gum
- ● - Sweetgum, Water Oak, Willow Oak
- ░ - Water Oak, Willow Oak
- ● - Sweetgum, Water Oak, Willow Oak, Nuttall Oak

Map 1. FOREST TENT CATERPILLAR DEFOLIATION 1990


KITTSON
ROSEAU
LAKE OF THE WOODS
MARSHALL
PENNINGTON
RED LAKE
KOOCHICHING
POLK
NORMAN
CLAY
WILKIN
GRANT
DOUGLAS
TRAVERSE
STEVENS
POPE
BIG STONE
SWIFT
STEARNS
BENTON
MILLE LACS
SHERBURNE
ISANTI
CASS
MORRISON
CARLTON
PINE
COOK
CHIPPEWA
KANDIYOHI
MEEKER
WRIGHT
HENNEPIN
WASHINGTON
LAC QUI PARLE
YELLOW MEDICINE
RENVILLE
McLEOD
CARVER
SCOTT
DAKOTA
SIBLEY
NICOLLET
LINCOLN
LYON
REDWOOD
BROWN
LE SUEUR
RICE
GOODHUE
WABASHA
PIPESTONE
MURRAY
COTTONWOOD
WATONWAN
BLUE EARTH
WASECA
STEELE
DODGE
OLMSTED
WINONA
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON
▩ = Light to moderate defoliation (< 50% of leaves defoliated).
▤ = Heavy defoliation (> 50% of leaves defoliated).

Based on aerial and ground surveys by DNR-Forestry Insect and Disease Staff. June and July, 1990.

Areas and Acreage Defoliated by the Forest Tent Caterpillar, 1990


DOUGLAS
BAYFIELD
ASHLAND
IRON
VILAS
BURNETT
WASHBURN
SAWYER
PRICE
FOREST
FLORENCE
ONEIDA
MARINETTE
POLK
BARRON
RUSK
LINCOLN
LANGLADE
OCONTO
TAYLOR
CHIPPEWA
ST CROIX
DUNN
MARATHON
MENOMINEE
CLARK
PIERCE
EAU CLAIRE
SHAWANO
DOOR
WOOD
PORTAGE
WAUPACA
BROWN
KEWAUNEE
PEPIN
BUFFALO
TREMPEALEAU
OUTAGAMIE
JACKSON
MANITOWOC
JUNEAU
ADAMS
WAUSHARA
WINNEBAGO
CALUMET
MONROE
LA CROSSE
MARQUETTE
GREEN LAKE
FOND DU LAC
SHEBOYGAN
VERNON
SAUK
COLUMBIA
DODGE
WASHINGTON
OZAUKEE
RICHLAND
CRAWFORD
DANE
JEFFERSON
WAUKESHA
MILWAUKEE
IOWA
GRANT
LA FAYETTE
GREEN
ROCK
WALWORTH
RACINE
KENOSHA

96,000
Acres
Defoliated

283,000
Acres
Defoliated
(includes
Marathon Co)

exceeding 60-70 trees per acre during the recent flight period. Local populations will continue to cause significant tree mortality in 1991; however, a continuing declining trend is anticipated.

REGION 4 (INTERMOUNTAIN REGION)

Activity is very low compared to past years primarily due to host depletion from past catastrophic infestations. The largest infestation, located in the Sawtooth National Recreation Area, Idaho, continues to kill lodgepole pine. In Utah, a small infestation located on the Manti-LaSal National Forest continues to kill ponderosa pine. Overall, 11,400 trees were killed on 7,800 acres in 1990.

SOUTHERN PINE BEETLE

REGION 8 (SOUTHERN REGION)

Populations appear to be decreasing throughout the southern Appalachian mountains and increasing on the National Forests in Texas and the Coastal Plain of South Carolina.

Because of the high beetle populations in Texas, a decision was made recently to treat a Wilderness Area. The major objective was to protect red cockaded woodpecker colonies (RCW). The RCW is a threatened species and requires mature living pines to survive.

South Carolina continues to have high beetle activity as a result of Hurricane Hugo, which devastated the area in September of 1989. Large tracts of pine sawtimber and pulpwood were either blown down or severely damaged by the 120 mile per hour winds. The Francis Marion National Forest alone has over 3,000 beetle spots. Many of these spots are in young precommercial stands and may exceed 30 acres in size. This situation is further complicated by: 1) the flooded marked conditions due to the large volume of timber that has already been salvaged because of Hurricane Hugo, 2) the considerable volume of damaged timber that has yet to be salvaged, and 3) the need to protect the remaining colonies of the red-cockaded woodpecker. Exact estimates of the loss are not yet available, but several million dollars worth of timber were damaged.

DOUGLAS FIR BEETLE

REGION 1 (NORTHERN REGION)

Douglas-fir beetle is the next most damaging bark beetle in the Region. Populations and infested acres are declining in response to salvage efforts and a return to more normal precipitation. Still, Douglas-fir trees on more than 20,000 acres were killed in 1989 and mapped as "faded" trees during annual aerial surveys in 1990. Ground surveys conducted throughout infested areas in 1990 indicated that, in most stands, populations have nearly returned to endemic levels.

REGION 4 (INTERMOUNTAIN REGION)

Extensive activity occurred throughout virtually all the host type in southern Idaho and areas in Wyoming and Utah. Large outbreaks are located on the Boise, Sawtooth, Payette, Salmon, and Caribou National Forests in Idaho, on the Bridger-Teton National Forest in western Wyoming and on the Wasatch-Cache National Forest in Utah. For 1990, approximately 162,700 trees were killed on over 154,600 acres.

WESTERN PINE BARK BEETLE COMPLEX

REGION 1

Both the western pine bark beetle (infests ponderosa pine) and the fir engraver (kills grand fir) were important forest pests in 1990. These bark beetles, like the Douglas-fir beetle, have taken advantage of near-drought conditions experienced from 1986-1988. Though populations of both bark beetles are abnormally high, and resultant tree killing is significant, recent drought relief should result in a lessening of their impacts in 1991. Approximately 15,000 acres and 80,000 acres, respectively, were infested by the two beetles. In the infested areas, an average of 1-2 trees per acre were killed.

Pine engraver beetles also killed several thousand ponderosa pines in scattered locations in eastern Montana. The spruce beetle and western balsam bark beetle remained at virtually endemic levels.

REGION 4

Mortality caused by the western pine beetle occurred primarily in second growth ponderosa pine on both the Boise and Payette National Forests in Idaho. Smaller infestations were observed on the Salmon and Sawtooth National Forests of southern Idaho. Over 23,800 trees were killed on 22,000 acres.

The spruce beetle also caused extensive mortality throughout its host type on the Payette National Forest in Idaho. Populations have been at outbreak levels for the last five years and in some areas 90 percent of the trees five inches DBH have been killed. In 1990, 193,000 trees were killed on 122,000 acres.

REGION 5

Since the drought began in 1988, the drought/bark beetle interaction as of July has resulted in an estimated loss of 2.68 billion board feet of commercial timber on State and Federal lands. Although figures are not available, additional losses occurred on private lands as well. Much of the loss has occurred in the Sierra Nevada and southern California.

REGION 10

In south - central Alaska, spruce bark beetle damage continues on 250,000 acres. White and Lutz spruce are the hardest hit.

GYPSY MOTH SUPPRESSION, 1990

State / Site	Dimilin	Bt	Other*	Total
DELAWARE				
Cooperative Suppression	42,462	15,256	0	57,718
IDAHO (co-op eradication)				
Couer d'Alene/Sandpoint	0	1,060 (3X)**	0	1,060 (3X)
MARYLAND				
Cooperative Suppression	83,595	104,128	0	187,723
Aberdeen Proving Ground	0	8,000 (2X)	0	8,000 (2X)
Adelphi Laboratory	70	30	0	100
Annapolis Naval Reservation	0	180 (2X)	0	180 (2X)
C&O Canal & GW Parkway	0	986	0	986
Fort Meade	0	6,300	0	6,300
Greenbelt ACE	0	247 (2X)	0	247 (2X)
Greenbelt & BW Parkway	0	1,108 (2X)	0	1,108 (2X)
NASA-Goddard	0	1,197 (2X)	0	1,197 (2X)
White Oak Naval Center	226	40	0	266
Pautuxent Wildlife Center	0	3,550 (2X)	0	3,550 (2X)
USDA-ARS Research Center	0	2,943 (2X)	0	2,943 (2X)
Youghiogheny Lake	0	16	0	16
MICHIGAN				
Cooperative Suppression	0	143,240	0	143,240
Huron-Manistee Nat'l Forest	0	784	0	784
NEW JERSEY				
Co-op Suppression (NJ Ag)	0	92,997	0	92,997
Co-op Suppression (NJ For.)	575	7,830	0	8,405
NEW YORK				
Seneca Indian Nation	0	1,980 (2X)	0	1,980 (2X)
NORTH CAROLINA (co-op eradication)				
Bert, Halifax, Northam Co.	0	4,200 (2X)	0	4,200 (2X)
PENNSYLVANIA				
Cooperative Suppression	117,888	274,232	0	392,120
Bureau of Prisons	127	0	0	127
Conemaugh Lake	0	150	0	150
Cowanesque Dam	0	102	0	102
Crooked Creek Lake	0	324	0	324
Fort Necessity Park	0	400 (2X)	0	400 (2X)
Gettysburg National Batfld.	0	56 (2X)	0	56 (2X)
Loyalhanna Lake	0	42	0	42
Mahoning Creek Lake	0	62	0	62
Raystown Lake	0	80	0	80
Youghiogheny Lake	0	164	0	164
TENNESSEE (co-op eradication)				
Sequatchie County	0	0	200	200
UTAH (co-op eradication)				
Wasatch Front	0	20,064 (3X)	0	20,064 (3X)
VERMONT				
Cooperative Suppression	0	8,050	0	8,050
Green Mountain Nat'l Forest	0	3,202	0	3,202

State / Site	Dimilin	Bt	Other	Total
VIRGINIA				
Cooperative Suppression	92,999	34,616	0	127,615
AIPM Project	27,220	59,081	811 (2X)	87,112 (2X)
Arlington National Cemetary	435	0	0	435
Blue Ridge Parkway	206	1,426	48 (2X)	1,680 (2X)
Dulles Airport	1,600	0	0	1,600
Fort Belvoir	137	0	0	137
Fredrick./Spots. Natl Batf.	0	230	0	230
GW Parkway	0	951 (2X)	0	951 (2X)
Manassas National Battlefld	0	186 (2X)	0	186 (2X)
Prince William Forest Park	0	654 (2X)	168 (2X)	822 (2X)
Quantico Marine Base	3,314	1,772	0	5,086
Shenandoah National Park	1,939	1,082	172 (2X)	3,193 (2X)
Smithsonian Zoological Park	100	0	0	100
Vint Hill Farms	185	0	0	185
Warrenton Training Center	371	0	0	371
WASHINGTON, DC				
National Arboretum	0	187 (2X)	0	187 (2X)
National Capital Parks	0	261 (2X)	0	261 (2X)
.WEST VIRGINIA				
Cooperative Suppression	186,306	145	0	186,451
AIPM Project	104,133	61,478	500 (2X)	166,111
George Wash. Natl Forest***	1,145	7,501 (2X)	250 (2X)	8,896
Monongahela National Forest	615	4,566 (2X)	275 (2X)	5,456
Jennings Randolph	150	0	0	150
GRAND TOTAL-GYPSY MOTH TREATMENT	665,798	877,136	2,424	1,545,358

* Other includes gypchek and disparlure.
** (_X) indicates the number of applications in a multiple application project.
*** Includes AIPM area.

Data obtained from the National Pest Suppression Tracking System, Forest Pest Management, Morgantown, WV. Revised 9/11/90.

GYPSY MOTH DEFOLIATION, 1989-1990

STATE	1989	1990
District of Columbia	0	10
Delaware	1,888	3,790
Connecticut	78,430	176,576
Massachusetts	950	83,595
Maryland	97,911	133,062
Maine	35,000	270,433
Michigan	294,344	358,338
New Hampshire	18,395	133,200
New Jersey	137,310	431,235
New York	421,138	354,162
Ohio	0	115
Pennsylvania	1,506,790	4,357,700
Rhode Island	0	0
Vermont	27,335	63,000
Virginia	289,332	594,000
West Virginia	86,736	338,746
TOTAL	2,995,559	7,297,962

Note: Data obtained from the GMDigest, Forest Pest Management, Morgantown, WV.

U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. [illegible]

DEPARTMENTAL REGULATION	**NUMBER:** 5600-1
SUBJECT: Departmental Gypsy Moth Policy	**DATE:** June 1, 1990 **OPI:** Forest Pest Management, S&PF, Forest Service

1 PURPOSE

This regulation establishes Departmental gypsy moth policy. It assigns responsibilities to USDA agencies and defines agency roles to avoid unnecessary duplication and to provide maximum coordination of USDA activities dealing with the gypsy moth.

2 BACKGROUND

The gypsy moth was introduced into this country in 1869. From 1869 to the 1950's, the moth spread throughout Maine, New Hampshire, Vermont, Rhode Island, and Connecticut. During the 1960's and 1970's, it moved into eastern Canada and Michigan and spread through New Jersey, much of New York, and Pennsylvania. In the early 1980's, it infested Delaware, Maryland, and portions of Virginia, West Virginia, North Carolina, and Ohio. Isolated infestations have been found in many other states, including California and Oregon. This spread resulted from both natural dispersal and accidental transport of gypsy moth life stages on recreational and commercial vehicles and outdoor household articles.

Gypsy moth damage and artificial spread of gypsy moth by people can be mitigated. USDA programs have been implemented for this purpose. Suppression programs are carried out to reduce gypsy moth damages, eradication projects are conducted to eliminate isolated infestations, and a quarantine is maintained to regulate the movement of gypsy moth by people. Research is underway to find better ways to cope with this insect. Extension and other education programs communicate essential information to the public.

USDA began its role in gypsy moth control in 1906 after Connecticut and Massachusetts requested aid from the Federal Government. Over the years, several USDA agencies became involved in work on the gypsy moth. These agencies are the Animal and Plant Health Inspection Service (APHIS), the Agricultural Research Service (ARS), the Cooperative State Research Service (CSRS), the Extension Service (ES), and the Forest Service (FS). Each agency has a distinct role in delivering the Department's gypsy moth program.

The role of APHIS is to administer the regulatory aspects of the program, conduct surveys to detect isolated infestations that are remote from the area of the United States that is generally infested, and develop methods to eradicate isolated infestations. APHIS also assists States with projects to eradicate small isolated infestations on private land. Gypsy moth research is conducted by the ARS, CSRS, and the FS. The ES coordinates education programs and disseminates information about the gypsy moth. The role of the FS, in addition to conducting research, is in gypsy moth survey and control within the generally infested area, either directly on Federal lands or cooperatively with the States on non-Federal lands, and in eradicating isolated infestations that are on or contiguous with Federal lands and large isolated infestations on non-Federal lands.

DISTRIBUTION: 56

3 POLICY

It is the policy of the Department to:

a Provide a comprehensive program of gypsy moth management activities coordinated by a designated lead agency.

b Protect Federal lands and assist States in protecting non-Federal lands from gypsy moth damage.

c Prevent or reduce the artificial long-range spread of the gypsy moth.

d Develop effective gypsy moth eradication or suppression programs.

e In cooperation with the States, conduct uniform gypsy moth surveys and population assessment activities.

f Plan and conduct fundamental and applied research on the gypsy moth in partnership with the Agricultural Experiment Stations and other cooperators to support Federal/State extension, regulatory and action programs.

g Coordinate research planning and cooperation within the Department and with other Federal, State, and private agencies.

h Emphasize research deemed necessary by Federal and State cooperators from the research, extension and action communities.

4 RESPONSIBILITIES

In carrying out Departmental gypsy moth programs, it is the primary responsibility of:

a The Forest Service to:

(1) Serve as lead agency for Departmental gypsy moth program activities.

(2) Provide technical assistance to State agencies within the generally infested area in gypsy moth detection, evaluation, and suppression techniques.

(3) Pilot test and transfer technology designed to improve gypsy moth control and damage reduction practices.

(4) Provide State and Federal agencies in the generally infested area and in newly infested States financial assistance in suppressing gypsy moth populations.

(5) Provide financial and technical assistance to State and Federal agencies to eradicate isolated gypsy moth infestations that are on or contiguous with Federal lands, and large isolated infestations that are on non-Federal lands.

(6) Conduct research and develop the means to control gypsy moth under forest conditions and to support agency action programs.

b The Animal and Plant Health Inspection Service to:

(1) Coordinate, with the appropriate State agencies, a national trapping program to detect isolated gypsy moth infestations.

(2) Conduct methods development and technology transfer activities to improve gypsy moth eradication and quarantine practices.

(3) Maintain a national quarantine to prevent the artificial long-range spread of the gypsy moth.

(4) Provide financial and technical assistance to States to eradicate small isolated gypsy moth infestations.

c The Agricultural Research Service to:

(1) Develop the means to protect high-value trees for homeowners, communities, parks and other non-forest environments.

(2) Conduct research supporting the activities of gypsy moth action agencies.

d The Cooperative State Research Service to:

(1) Administer a research grants program, that includes gypsy moth research, and cooperative planning through the State Agricultural Experiment Station System.

e The Extension Service to:

(1) Coordinate an information and education program carried out by Departmental and appropriate State agencies on gypsy moth and gypsy moth management practices.

-END-

The Status of the Hemlock Looper in Maine
September 1990

Henry Trial Jr.

In 1988, populations of the hemlock looper in Maine began an unprecedented increase. This insect, though native to Maine, previously was most commonly found in low numbers. Damaging population had been seen only three times in this century for a total of 150 acres; Bath area (1927), Wiscassett (1964), and Nobleboro (1966). Evidence of a building outbreak in 1988 was limited to numerous reports of higher than normal moth activity. In 1989, 450 acres of heavy to severe defoliation were mapped near Sebago Lake and on islands in eastern Maine lakes near Springfield. Also in 1989, a significant increase in moth activity was noted in eastern Maine. Similar unprecedented increases in looper were also noted in neighboring New Brunswick.

Surveys and Observations

In the Fall of 1989, egg densities were estimated in and near defoliated areas and in areas where heavy moth activity had been reported. Mean egg counts of 5 to 10 eggs per branch were found in Lakeville and Macwahoc. All other areas surveyed had mean egg counts less than 2 per branch including areas near Sebago Lake where heavy damage was seen. Based on Canadian data derived from fir, the higher egg counts were expected to cause only moderate damage.

In March and April of 1990 three research areas were established to determine the relationship between egg density, larval counts, and resulting defoliation. Basic research on population evaluation and prediction on hemlock had not been done previously, and this information was needed to evaluate this apparently worsening problem. Preliminary data show that egg counts of 6 to 10 eggs per branch resulted in heavy to severe defoliation on hemlock. Counts of 2 to 5 eggs resulted in moderate damage. The egg to defoliation relationship for fir was not studied in 1990 but observations and Canadian data suggest that 10 or more eggs are needed to result in heavy damage.

All evaluations of looper conducted during the summer of 1990 support the view that the hemlock looper infestation in Maine continues to move toward widespread outbreak conditions and consequently heavy damage. In late June, a survey of early larval populations was conducted in and around the known infested areas. Larval counts ranged from 10 larvae per branch in areas not showing looper damage to 170 per branch in Lakeville where damage was seen in 1989. Areas where heavy moth activity had been observed were surveyed and counts of 30 to 70 larvae were common. Late larval counts were taken in August at the same trees that had been sampled for eggs in March. By this time larvae were .5 to 1" in length and natural mortality and dispersal had reduced numbers to the 10 to 25 per branch.

Observations of the pattern and intensity of hemlock looper defoliation were made throughout the summer. We learned that the looper feeds on new foliage soon after egg hatch yet, at population levels seen in Maine in 1990, no significant damage was caused by these tiny larvae. Older larvae had a definite preference for old needles and did not move to new growth until nearly all old needles were gone. Most needles were not totally consumed but larvae nibbled the needles causing them to die and fall from the tree. In areas of moderate population, larvae never caused significant damage to new needles. In high population areas 30 to 100% of the new needles were eaten or destroyed and 95 to 100% of the old needles were lost. In the most severe spots, hemlock lost 90 to 100% of the total needle compliment and are not expected to survive. Damage to fir and spruce was far less intense in most areas. In areas where hemlock lost nearly 100% of its needles, fir lost about 50 to 70% of the old needles and almost no new needles. In one area, fir and spruce on islands off Mount Desert Island lost 50 to 100% of the total needle compliment and some trees will die.

An aerial survey was conducted during September of 1990 over much of Maine. More than 20,000 acres of heavy to severe damage was mapped (Figure 1). Light to moderate damage was not visible from the air but ground observation suggests that areas of light to moderate damage may exceed 80,000 acres. A ground survey near known infestations has begun and is likely to extend through the fall. A map of the light to moderate defoliation will be prepared when the survey is complete.

Light traps have been used for many years in Canada to monitor looper moth activity and seem to be a useful measure of population density. Because looper moths fly from August through mid October, and Maine light traps have normally operated in June and July, Maine has no light trap record of previous looper activity. In 1989, however, one light trap operator in Steuben voluntarily operated a trap in the fall. In 1990 the MFS extended the operating season of 8 of its traps to include September specifically to evaluate looper. In 1989 the Steuben trap caught large numbers of moths relative to past Canadian data. Trap catch data for 1990 is not yet complete but to date the Steuben trap has caught huge numbers of moths; several times the already high 89 level. Also, some other traps such as Topsfield have caught high numbers. This preliminary light trap data verifies numerous reports of extensive moth activity from all over eastern Maine. Large numbers of moths have be reported by those working in the woods, on buildings near lights, and even by motorists driving at night. Higher levels of moth activity than that seen in 1989 have occurred nearly statewide.

Another year of heavy feeding is likely to cause significant hemlock mortality in central Penobscot, northern Hancock, northern Washington, central Lincoln, and southern Aroostook Counties. High populations in portions of southern Washington County would probably cause significant defoliation to fir and possibly spruce in 1991. Stands of hemlock in the Sebago Lake area are also at high risk if looper populations are high. In addition many new defoliated areas are likely to appear in 1991. Two preliminary egg counts taken in October of 1990 from Lakeville and Webster were 20 and 26 eggs per branch. Both are three times the highest mean counts in 1990.

Future Plans

A 1990 - 1991 egg survey began in October. Egg densities will be estimated in and near known heavily infested areas. If time and resources permit, samples will be taken from more lightly infested areas. Infestation levels will be reported to landowners along with an assessment of the risk to their stands in 1991. Also, survey method research conducted in 1990 must be repeated to verify preliminary relationships.

Little is known about the specific impact of looper on hemlock. To evaluate the impact, the MFS plans to establish impact plots in several stands which show varying degrees of damage. Infestation and host tree data will be collected annually and the impact determined over time.

The MFS must investigate the management possibilities for this potentially serious pest. The province of Newfoundland has extensive experience with the use of biological and chemical incecticides to control looper. In 1990, New Brunswick also used insecticide to control a growing looper infestation. The MFS will consult with scientists from both jurisdictions and with the Canadian and U.S. Forest Services. Looper outbreaks are generally intense but of short duration. This type of infestation pattern may lend itself to carefully targeted spraying.

Salvage has already been used to reduce losses caused by hemlock looper in Maine. To be effective this option requires precise survey and predictive data. The MFS will discuss this option with affected landowners.

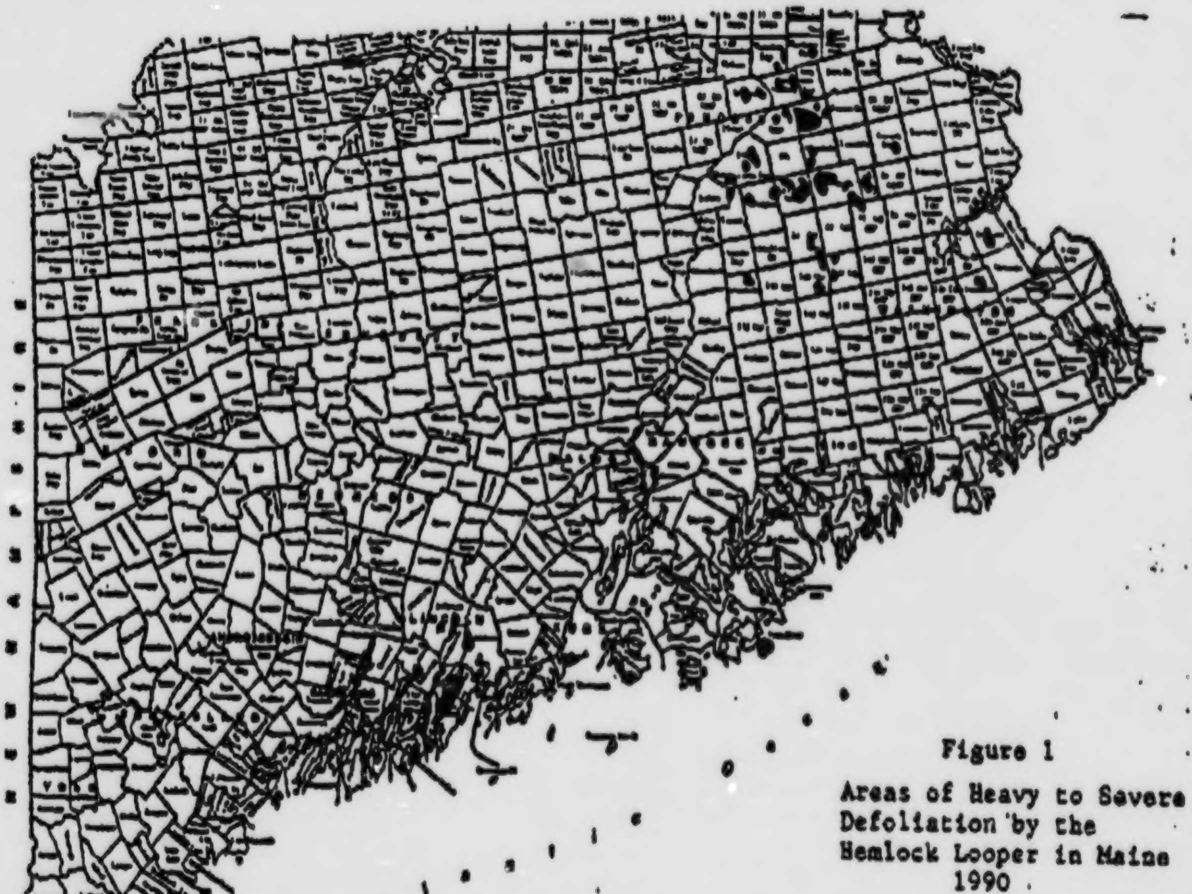


Figure 1

Areas of Heavy to Severe Defoliation by the Hemlock Looper in Maine
1990

October 19, 1990

By Henry Trial Jr., MFS

GYPSY MOTH CONDITIONS - MAINE, 1990

Dick Bradbury
Maine Forest Service

Gypsy moth defoliated 270,537 acres in 1990, continuing its epidemic phase which began in 1989 in Maine. Populations remain in the southwestern portion of the State where hardwoods, particularly red oak, are the predominant species.

Overwintering survival of eggs is often low in Maine, but mild winter temperatures and consistent snow cover on the ground have combined to allow high percentage survival of eggs since the winter of 1988-89. Egg hatch above and below the snowline was very high in both 1988 and 1989 nearing 100% in many areas.

Aerial surveys conducted during July to determine the size and intensity of the infestation revealed 46,512 acres of light (less than 30%) defoliation, 82,475 acres of moderate (31-60%) defoliation and 141,550 acres of heavy (greater than 60%) defoliation.

Pheromone trapping was conducted in an east-west band across the northern edge of the gypsy moth quarantine zone within the state using "milk-carton" traps baited with "+" disparlure. The number of moths caught in 1990 exhibited increases over 1989 catches in 196 of 235 traps placed. Again in 1990 traps utilizing "racemic" lure were placed within the infested area, the number of moths caught were substantially less than the numbers in 1989.

Egg mass sampling is currently underway, with 41 of a proposed 75 sites sampled. Plots to date have a mean of 2,848 egg masses/acre ranging from 0 to 10,688. Many of the masses are small and show high levels of parasitism by *Ooencyrtus kuvanae* (Howard) indicating poor general health of the population. Areas infested since 1989 are likely to drop out but population shifts to nearby locations should keep the acreage levels constant or show an increase in 1991.

Suppression projects in 1990 were entirely privately contracted and funded using both ground and aerial methods of application. B.t. was utilized almost exclusively on the approximately 2000 acres treated.

The Maine Forest Service has requested to be included in the 1991 Cooperative Gypsy Moth Suppression Project for a maximum of 25,000 acres. Although, town response to the project has initially been high, but acreage treated in 1991 will very likely be low.

II. Vegetation Management Summaries/ Résumeés portant sur la répression de la végétation

Canadian Vegetation Management Alliance (CVMA) Activities in 1990

A Report to the 18th Annual Forest Pest Control Forum
(Ottawa, Ontario 20-22 November, 1990)

Phillip E. Reynolds
President, CVMA

Canadian Vegetation Management Alliance
P.O. Box 675
Abbotsford, British Columbia
V2S 6R7

FAX (604) 850-9278

Canadian Vegetation Management Alliance (CVMA) Activities in 1990

Phillip E. Reynolds,
President

As previously reported (17th Annual Pest Forum Report), the Alliance was federally incorporated in October 1988. An attached brochure provides a list of our members and explains the CVMA's goal, objectives, and current and future activities.

The current officers of the CVMA are:

Past President: Ron King, IVMAA (Asplundh Utility Services, Edmondton),

President: Phil Reynolds, OVMA (Forestry Canada, Sault Ste. Marie),

Vice President: Ray Wellman, CVMA (Chevron Chemical (Canada) Ltd., Burlington)

Treasurer: Kim Hughes, AVMA (Dow Chemical Inc., Halifax), and

Secretary: Lovell Ritchey, IVMABC (Arbor Applicating Ltd., Abbotsford).

Other directors of CVMA, elected to a three-year term beginning in October 1988, include: Peter Romkey, AVMA (Nova Scotia Lands & Forests, Truro); Errol Taggart, Man./Sask. IVMA (Manitoba Hydro, Winnipeg); Garry Boves, Man./Sask. IVMA (Agriculture Canada, Regina); Larry Beaton, IVMAA (TransAlta Utilities Corp., Calgary); and Mel Scott, IVMA of BC (BC Ministry of Forests, Vancouver).

In the two years since our incorporation, the CVMA has been actively engaged in a number of activities. Early activities are reported in last year's Forum Report. These included: 1) representation of members views to government officials concerning the future registration status of 2,4-D in Canada and 2) membership on the Forest Pest Management Caucus (formerly Forestry Pesticides Caucus).

Activities During 1990:

1) Manitoba/Saskatchewan Industrial Vegetation Management Association joins CVMA:

During 1990, the Manitoba/Saskatchewan IVMA was incorporated, and became the newest member association of the CVMA. Directors from this group include: Errol Taggart and Gary Boves.

2) Participation in pesticide registration reform process:

Recently, the CVMA participated in public hearings (Winnipeg) conducted by the federal Pesticides Registration Review Team, and submitted a brief to the

Review Team outlining the CVMA's views concerning proposed reforms in the federal pesticides registration process. A copy of this statement is available upon request.

The Review Team was commissioned by the federal Minister of Agriculture. The Review Team held public hearings across Canada during the fall of 1990 to solicit further input, and will make its final recommendations to the Minister of Agriculture for registration reforms in late 1990.

3) Cooperation with CAPCO to achieve inter-provincial reciprocity in pesticide licensing and certification:

In October 1990, the CVMA was asked by the CAPCO (Canadian Association of Pesticide Control Officials) Task Force of Provincial Pesticide Training Officers to assume a lead, cooperative role in achieving inter-provincial reciprocity in pesticide licensing and certification. The CVMA hopes to achieve reciprocity through the endorsement and regional modification of a national core manual of standards and good practices for vegetation management.

4) Development of a national core manual of standards and good practices for vegetation management:

During 1990, the CVMA has developed a generic core manual based upon a regional model originally published by the Industrial Vegetation Management Association of Alberta (IVMAA). The CVMA plans to publish a core manual, which can be used on a national basis, in the first half of 1991. A first draft of the manual is finished, and will be printed in early 1991. Hopefully, revision and finalization will be finished by June. The manual will be finianced by donations from members and others, and via a pre-sales campaign. Those wishing to make a financial donation to the project or pre-purchase copies should contact the CVMA.

This national core manual will be relevant to all aspects of vegetation management, and could be used as a basis of national certification standard for more than one pesticide application category (e.g., agricultural, forestry, industrial, landscape, aerial). To date, the national core manual has also received endorsement from the Crop Protection Institute of Canada (CPIC) and from the Canadian Agricultural Aviation Association (CAAA). Both groups will work cooperatively with the CVMA and CAPCO in finalizing the core manual.

The core manual will then be adopted for use by our other regional members. These members will add appropriate provincial regulations to the core manual, making the document useful across Canada. Our ultimate goal with the core manual is to attain provincial regulatory support across Canada.

In recent months, the Canadian vegetation management industry has been warned to police its own activities and develop professional standards of operation which will withstand public scrutiny. If the industry fails to do so, we believe it is only a matter of time before such standards will be regulated. Therefore, we believe that provincial regulators will enthusiatically embrace any meaningful attempt by the industry to police itself. The core manual, adopted across Canada, provides regulators with this opportunity.

This manual will assist the CVMA in achieving a proactive public relations campaign, and will provide a foundation for creation of a national certification program for herbicide applicators and acceptance of interprovincial reciprocity in pesticide licensing.

5) National fund-raising campaign:

The CVMA will soon embark on a national fund-raising campaign. The purpose of this campaign is to establish a sustaining trust fund for the CVMA. Such a trust fund will ensure that 1) the CVMA is sustained and 2) provide enhanced funding to make the CVMA a more powerful lobby for the vegetation management industry.

During our incorporation, the CVMA was careful to ensure that financial gifts could be received without any restrictions. Gifts received will be placed in a trust fund, the interest from which will provide regular operating income for the CVMA to achieve its objectives. The fund will be administered by a Canadian chartered bank or trust company in accordance with guidelines legally established by the trust. The funds will be invested as determined by the board of directors of the Alliance, in accordance with incorporated by-laws. However, strict guidelines of the trust shall specify that only income generated by the trust may be utilized for purposes of general operating revenues.

Communication with the Alliance may be made by contacting any of the directors or through the CVMA Secretary, Mr. Lowell Ritchey, P.O. Box 675, Abbotsford, B.C., V2S 6R7. FAX (604) 850-9278.

CURRENT AND FUTURE ACTIVITIES

1. Code of Good Practice or Operating Protocol. We are working to develop a national standard of use, application, testing, acceptance, etc. of vegetation management techniques.
2. Creation of a National Certification Program for applicators. This would involve the development of a core program plus regional addenda. The program would encourage uniformity of practice and levels of acceptance across the country.
3. Reciprocity of Pesticide Licensing among Provinces.
4. Insurance Liability. We believe there is a need to establish a mechanism whereby individual companies could get a reduction in premiums if they subscribed to the CVMA and adopted a Code of Good Practice.
5. A Public Relations Campaign: We favor a proactive campaign to show the public the positive aspects of the Alliance and its charter members.

CVMA
CANADIAN VEGETATION
MANAGEMENT ALLIANCE

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CVMA

CANADIAN
VEGETATION
MANAGEMENT
ALLIANCE

CVMA

The CVMA was federally incorporated in October 1988, and membership is comprised of regional vegetation management associations including:

The Atlantic Vegetation Management Association

The Ontario Vegetation Management Association

The Industrial Vegetation Management Association of Manitoba/Saskatchewan

The Industrial Vegetation Management Association of Alberta

The Integrated Vegetation Management Association of British Columbia

Membership in the regional organizations consists of every sector of the vegetation management industry including weed inspectors, agrologists, engineers, applicators, consultants, herbicide manufacturers, foresters, government officials, rights-of-way managers, highway managers, etc. Regional membership does not tend to include farmers, except in Atlantic Canada.

GOAL

The goal of the ALLIANCE is to represent its members on a national basis. The ALLIANCE is the only nationally incorporated group that represents regional members engaged in a broad spectrum of professional vegetation management activities.

OBJECTIVES

The objectives of the CANADIAN VEGETATION MANAGEMENT ALLIANCE are:

1. To provide a forum for discussion of vegetation management concerns;
2. To encourage a better and more thorough understanding of the vegetation management industry;
3. To promote professionalism within the vegetation management industry
4. To establish and maintain a liaison between the vegetation management industry and all levels of government;
5. To represent the concerns of the vegetation manager to the government;
6. To represent members views on current legislation, government regulation, and public concern affecting vegetation management;
7. To monitor proposed legislation and government regulation on matters potentially affecting vegetation management;
8. To embody the objectives of all member associations;
9. To foster interprovincial reciprocity with regards to pesticides licensing;
10. To educate the public concerning various vegetation management activities;
11. To do all such other things as are incidental or conductive to the attainment of the above objects.

The ALLIANCE believes that informed and educated decisions can best be made when all available information is presented.

Herbicides Research Conducted by FP-54-1 in 1990

A Report to the 18th Annual Forest Pest Control Forum
(Ottawa, Ontario 20-22 November, 1990)

Phillip E. Reynolds

Project No. FP-54-1 - Weed and Crop Ecology

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P6A 5M7

Herbicides Research Conducted by FP-54-1 in 1990

Phillip E. Reynolds

Since the last Pest Forum, FP-54-1 has focused its efforts on preparing several manuscripts for journal publication. These manuscripts all relate to crop growth response following site preparation with hexazinone (liquid and granular), metsulfuron, and sulfometuron.

In addition, more research relating to the nature and effects of raspberry competition on crop growth was initiated in 1990. Currently, a research proposal is being prepared for 1991 which will focus on an examination of raspberry competition as it effects sustained growth of planted black or white spruce on clear-cut sites, treated or untreated with herbicides.

Objectives:

The new research has two broad objectives including:

1) a thorough examination of the nature of the competition (i.e., what is being competed for: available nutrients, light, or moisture, and to what extent is each of these factors important in limiting crop growth?) and

2) how long can crop growth increases, resulting from vegetation management, be sustained, without additional intervention?

Progress to Date:

FP-54-1 research on vegetation management of eastern spruce plantations began in 1984, and has continued to evolve to the present time. This work has included site preparation with all formulations of hexazinone and release with glyphosate. Early work focused on herbicide efficacy, crop tolerance and survival, and plant succession. To date, approximately 14 papers have been published on this aspect of the work.

Since 1988, FP-54-1 research has focused on spruce growth response to vegetation management. Specifically, we have sought to understand how growth response is related to differing levels of raspberry competition. Various techniques for measuring above-ground raspberry competition have been examined, and the relationship of spruce growth to raspberry competition has been mathematically examined. To date, 2 growth papers have been published, and 6 journal papers are in various stages of preparation.

Since 1989, FP-54-1's research has focused on developing a better understanding of the nature of the competition. This has included: 1) better quantitation of the competition (i.e., both above- and below-ground biomass) and 2) quantitation of the competition in terms of various factors (i.e., nutrients and light) which have a direct influence on growth.

In 1989, nutrient sampling of white spruce foliage, soil, and of raspberry and fireweed tissues (foliage, canes/stems, and roots) was initiated to better understand the niches of raspberry and fireweed in processing nitrate within clear-cut ecosystems and to determine if crop growth was restricted due to any nutrient deficiencies.

In 1990, nutrient sampling was extended to include a second vegetation management site characterized by severe, rapidly developed raspberry competition. Nutrient sampling included black spruce tissues (i.e., foliage, leader, stem, branches, roots), soil, and above-ground tissues and roots of both cane and trailing raspberry. All sampling was done within a 1-m radius of the sacrificed crop tree. Nutrient analysis, coupled with biomass determination, will provide a better understanding of raspberry competition for nutrients, and of possible impacts of this competition on crop growth.

In 1990, new studies were also initiated to determine the role of raspberry in competing for available light needed to maximize crop growth. Light meter measurements of available light were made for crop trees subjected to varying degrees of raspberry competition ranging from overtopped to free of competition. Light measurements were taken at tree base, mid-tree height, and at leader tip. These measurements were then related to growth response, crop health, and competition levels via regression analysis. Preliminary results strongly suggest that light is probably the major competition factor affecting height growth.

Other data collected to date, suggests that site moisture is probably the major competition factor affecting diameter growth. Nutrient availability is likely influenced by individual site moisture differences, since soil saturation determines whether essential nutrients are readily available in soil solution. Tree photosynthesis is the best overall integrator of these growth factors, since photosynthesis is dependent upon both available light and water.

Proposed Research for 1991 and 1992:

A proposal is currently being prepared for possible funding which seeks to extend competition research begun in 1989. Key facets will include:

1) Extension of nutrient and raspberry biomass research to a third site.

Raspberry biomass estimates for the two sites already studied suggest there is considerable site variability in raspberry biomass and root morphology, and these differences are probably related to significant differences in available water. In order to examine this relationship in greater depth, a third site which is intermediate in soil moisture and raspberry competition will be studied.

We believe there is a definite relationship between soil moisture levels and raspberry biomass and root structure. It appears that raspberry competition develops more rapidly on wet sites, and that root biomass is greater on drier sites. Because of this relationship, nutrient competition is likely to vary widely from site to site.

2) Measurement of soil moisture on three sites which vary widely in available water.

Measurements will be taken at the two sites previously sampled for nutrients and at a third site described above. Measurements of soil moisture will be used to determine more precisely the relationship of crop diameter growth to site moisture conditions. These measurements will also be used to test the validity of a relationship between soil moisture levels and raspberry biomass and root structure. Finally, the measurements will be used in conjunction with tree photosynthesis and transpiration measurements described below.

3) Measurement of crop tree photosynthesis and transpiration on three sites which vary widely in available water and raspberry competition levels.

Measurements of photosynthesis will be taken at the three sites described above. Based upon light competition measurements taken last summer, we plan to model the effects of light competition on crop growth response by estimating available light reaching the tree surface from its leader to its base. Tree photosynthesis measurements will provide a more precise measure of crop productivity in relationship to available light and soil moisture. Transpiration measurements will provide information on plant water uptake in relationship to soil moisture conditions. Photosynthesis and transpiration measurements will be used in multiple regressions which relate crop growth and/or productivity to photosynthetic and transpiration rates, competition levels, crop health, and light, soil moisture, and nutrient availability.

4) Measurement of raspberry photosynthesis and transpiration on three sites which vary widely in raspberry competition levels and soil moisture levels.

A similar approach to that described above will be used.

Publications in 1990:

FP-54-1 journal publications appearing in 1990 include the following.

Feng, J.C., D.G. Thompson, and P.E. Reynolds. 1990. Fate of glyphosate in a Canadian forest watershed. I. Aquatic and off-target deposit assessment. J. Agric. Food Chem. 38: 1110-1118.

Payne, N.J., J. Feng, and P.E. Reynolds. 1990. Off-target deposit measurements and buffer zones required around water for aerial glyphosate applications. Pestic. Sci. 30: 183-198.

Other Activities:

Career development leave for P. Reynolds will be initiated in early 1991 with the U.S. Forest Service Silviculture Laboratory located in Redding, California. The purpose of the leave will be:

1) To gain expertise in alternative silvicultural strategies for controlling competing forest vegetation.

2) To develop a problem analysis for Forestry Canada and FPMI on alternative silvicultural strategies for controlling competing forest vegetation. The problem analysis will be used to define and implement new research directions for FPMI and Forestry Canada in this area.

3) To initiate new research on alternative silvicultural strategies for controlling competing forest vegetation as appropriate.

The Redding Silviculture Laboratory in Redding, California is one of the leading silviculture laboratories in the world involved in the study of competing forest vegetation and the development of operational strategies for the control of this vegetation. Within the U.S. Forest Service, it is the lead laboratory nationally to be charged with this responsibility. Faced with public opposition to chemical herbicide use, the U.S. Forest Service has effectively demonstrated that alternative silvicultural strategies do work, and can be operationally implemented within a relatively short time frame.

Various forestry practices affect the composition and severity of competing vegetation in conifer plantations. These include pre- and post-harvest activities (i.e., prescribed burning, mechanical site preparation, and vegetation management practices), harvest method, and time of harvest. In addition, the composition and density of competing vegetation in young conifer plantations is also influenced by location, stand history, and stand condition at the time of harvest. Hence, alternatives to affect the composition and density of competing vegetation in these plantations are not restricted to direct control (i.e., chemical, manual, mechanical, fire, grazing, combinations thereof) of existing vegetation. By understanding those factors (i.e., environmental, biological, and historical) and forestry practices which determine the composition and intensity of forest weeds competition in young conifer plantations, it is possible to develop stand prescriptions which integrate harvesting and stand regeneration activities. Such prescriptions are capable of preventing or lessening weed competition in new plantations. This indirect approach to vegetation management is proactive rather than reactive, and offers greater flexibility in stand establishment.

Alternative silvicultural strategies for managing competing forest vegetation offer a viable, short-term solution for effectively managing weeds via indirect means. These strategies, along with bioherbicides, are viewed favorably by the public, and are often more readily accepted because of their proactive, preventative stance on forest weeds management as opposed to a reactive, catch-up stance associated with weed problems which have been allowed to develop. In keeping with the reality of the current public attitude on chemical herbicide use, it is important to expand existing programs to include acceptable alternatives. This includes both alternative silvicultural strategies and development of viable bioherbicides. In conjunction with these expanded research programs, FPMI will continue to maintain strong research programs aimed at developing improved use strategies for registered chemical herbicides.

Individuals or organizations having further questions about this research should contact P. Reynolds at FPMI or telephone (705) 949-9461.

NEWFOUNDLAND

HERBICIDE SPRAY PROGRAMS - FOREST SITES

(Presented at Pest Control Forum, Ottawa, Nov. 20-22, 1990)
(by H. Crummey)

SUMMARY TABLE OF AERIAL * HERBICIDE SPRAY - NEWFOUNDLAND 1984-90

YEAR	AREA(ha)	# SITES	PRODUCT	RATE L/ha	PRESCRIPT [a]
1984	259	5	Vision	3 & 6	C, P, S
1985	475	4	Vision	4.25	P, S
1986	99	1	2,4-D D-A	5.0	P
	393	1	2,4-D Est	5.5	C
	556	2	Vision	3 & 4.25	C, P, S
	1048				
1987	1613	6	Vision	4 & 6	C, P, S
1988	1010	6	Vision	4	C, P, S
1989	2312	8	Vision	4, 5 & 6	C, P, S
1990	2844	8	Vision	4 & 5	C, P, S

TOTAL 1984-90 9561 Hectares

SUMMARY TABLE OF GROUND ** HERBICIDE SPRAY - NEWFOUNDLAND 1984-90

YEAR	AREA(ha)	# SITES	PRODUCT	RATE L/ha	PRESCRIPT [a]
1990	25	1	Vision	4	P

* Using helicopters with boom & nozzle
** Using back-packs

a C = Conifer release
P = Plantation release
S = Site preparation

1990 SUMMARY OF HERBICIDE TREATMENTS IN NEW BRUNSWICK

Area Treated (ha)

	CATEGORY				AIRCRAFT		
Agency	Plantation Tending	Natural Release	Site Preparation	1989 Banding	Fixed Wing	Rotary Wing	Total
N.B.D.N.R.							
Crown Land	9450	3548	120	1024	4900	9242	14142
Small Freehold (C.F.S.)	16	-	-	-	-	16	16
	9466	3548	120	1024	4900	9258	14158
Large Freehold							
J. D. Irving	8357	2744	700	350	9297	2854	12151
Fraser (Proposed)	5788	2097	1113	2371	-	11369	11369
N.B.I.P.	500	500	-	-	1000	-	1000
	14645	5341	1813	2721	10297	14223	24520
TOTAL	24111	8889	1933	3745	15197	23481	38678

1. All herbicide treatments carried our aerially.
2. Vision used operationally at rates of 3.7 L to 4.9 L per hectare.
3. Garlon used experiementally at 6.0 L/ha on approximately 520 ha.
4. Total spray volumes (Vision or Garlon + water) at 37 L/ha.

N. Carter, Director
Forest Pest Management
Dept. Natural Resources & Energy
P.O. Box 6000
Fredericton, N.B. E3B 5H1

III. Regulatory Considerations/Considérations sur la réglementation

Pesticide Registration Review

A CHRONOLOGICAL HISTORY

by J.-P. Martel

MARCH 1989

- The Minister of Agriculture, the Hon. Mr. Mazankowski, announces a review of the Canadian pesticide registration process
  Chairman: Ghislain Leblond
  Director: Hajo Versteeg

APRIL 1989

- First meeting of the Forestry Pesticides Caucus to coordinate input of the forest sector in the process

JUNE 1989

- Announcement of Review Team Membership:

  1 biological
  1 consumer group
  2 environment
  2 farming community
  1 labour
  1 public health
  1 forestry sector
  2 pesticide industry
  3 federal regulatory agencies

- First meeting of the Review Team
- Call for briefs

OCTOBER 1989

- Agreement on the general principles of an ideal registration system

  1. Open
  2. Protection of health, safety, and environment
  3. Accountable, responsible, efficient, fair, and equitable
  4. Responsive, adaptive
  5. Increase access to alternative pest management strategies that reduce risk of harm to health and environment.
  6. Support development of policies that assist economic viability/ competitiveness of farm/forestry/fisheries

JANUARY 1990

- Deadline for briefs (170)
- Forestry Pesticides Caucus briefs tabled

MAY 1990	■ Draft #5 of the proposal
JUNE 1990	■ The Review Team Chairman tabled a new proposal in an attempt to reach a consensus
JULY 1990	■ Release of the document "A Proposal for a Revised Federal Pest Management Regulatory System" ■ Announcement of public meetings ■ Only labour do not sign the document and release an independent report
SEPTEMBER 1990 - OCTOBER	■ Public meetings; more than 400 presentations
NOVEMBER 1990	■ Identification of sections or issues to be revisited. Main issues: - Statement of objective - Locus - Harmonization - Public access - Minor Registration - Pricing - Export - Role of provinces - Risk/Value assessment - Pest Management Promotion Office - Implementation strategy ■ Chairman will write a new proposal, that will be submitted to the Team
DECEMBER 14	■ Deadline to reach consensus
DECEMBER 20	■ Final report to the Minister
1991	■ Minister's decision ■ Writing of legislation ■ Implementation

The National Forest Pest Management Caucus

The Caucus is a national body of pest management experts representing the forest industry, provincial and federal governments, academia, various interest groups, and the forestry profession. Recently, the Caucus has been successful in dealing with two national forest pest management projects: first, the review of the federal pesticides registration process, and secondly, the development of economic benefit studies on forest pest management technology. Caucus activities are directly related to specific projects. The Caucus is not a permanent committee of the Canadian Council of Forest Ministers (CCFM); it is an independent body.

The attached Terms of Reference provides more information on the objectives and structure of the Caucus. It is worth noting that the Terms of Reference requires individual agency support of their representatives on the Caucus. Using this approach, agencies will attend when the projects being worked on are of significant interest to warrant the costs involved. It will also help keep the agenda germane to the entire forest sector.

The Caucus would like to inform the CCFM of its Terms of Reference and ask that CCFM members continue to support the involvement of government pest management experts in the work of the Caucus. The Caucus would also like to offer their help to the Council on any national pest management issues that they feel the Caucus should act upon.

National Forest Pest Management Caucus

TERMS OF REFERENCE

Rationale

The National Forest Sector Strategy for Canada, issued in 1987, recommended the following:

Recommendation #9: It is recommended that all elements of the forest sector recognize that pesticides are among the legitimate means for effective forest management in specific areas, that their use continue to be regulated; and:

- ensure that all pest management operations are ecologically and economically justified;
- encourage development and use of effective alternative methods of pest control, including integrated pest management;
- accelerate research into the environmental effects of pesticides; and
- ensure that the process for registration of pesticides for forest use is not cost-prohibitive and is open to public scrutiny.

In order to implement this recommendation, representatives from the forestry sector have recommended the formation of a National Forest Pest Management Caucus. National organizations such as the Canadian Council of Forest Ministers are requested to recognize the Caucus as the national body dealing with the technical aspects of the pest management issues related to forestry.

Objective

The objective of the Caucus is to promote and communicate the interests of the forestry sector in the protection of the forest resource from the threat of mortality, damage and growth losses caused by insects, diseases, weeds, and other forest pests. Specifically, the Caucus will act upon issues of common interest which are brought before it which may be in the interests of fulfilling its objective. Activities will be directly related to projects.

Such matters include:

1. Coordination and development of the forest sector's input into federal and provincial regulation of pesticides. Currently, the input to the Pesticide Registration Review is one of the major activities of the Caucus.

2. Coordination of general studies to support the need and standards for protection programs against forest pests. Currently, the Caucus is involved with three economic benefit studies: fenitrothion, triclopyr, and the need for forest pest control in Canada.

3. Working with regulators, the private sector, and resource users to facilitate the development and the registration of new pest control technology.

4. Promotion of the use of new pest control technology, including integrated pest management.

5. Coordination of national research on the environmental effects of forestry pesticides.

6. Advising the forestry sector on national and provincial policy matters relating to forest pest management.

Structure

Membership of the Caucus will be drawn from the following organizations and associations: provincial forestry departments; provincial forestry industry associations; Canadian Pulp and Paper Association; Forestry Canada; Canadian Institute of Forestry; Canadian Federation of Woodlot Owners; Canadian Vegetation Management Alliance; Canadian Forest Nursery Weed Management Association; Association of University Forestry Schools of Canada; and other groups as needed.

Each representative is requested to report to their organization on Caucus activities.

The Caucus will elect a Chairman and an Executive Committee every two years.

The Executive will be made up of:

- A Chairman
- A Secretary/Treasurer
- One (1) industrial representative
- One (1) provincial representative
- One (1) federal representative
- One (1) representative from the Caucus at large

The Caucus will also give specific mandates to subcommittees.

Meetings

The Caucus will meet once a year. Additional meetings could be called depending on emerging issues and projects.

Funding

This issue should be addressed by all members of the Caucus through their own sponsoring agencies.

November 5, 1990

:FPCaucus
:terms

STATUS OF MINOR USE PROGRAM SUBMISSIONS

Prepared by Coordinators' Office, SIRS
JUNE 1990

SUB. #	ACTIVE INGREDIENT	HOST(S)	PROV	STATUS	LAST ACTION	E.F.
86-500	DODINE	CONIFER SEEDLINGS	BC	08 EFFICACY & TOLERANCE	1988.03.04	1989.12.12
87-512	DIPHENAMID	CONTAINER NURSERY STOCK	ON	12 REGISTRANT	1988.08.04	1990.06.01
88-504	SIMAZINE	CONIFERS SITE PREPARATION	NS	12 REGISTRANT	1989.04.29	1990.06.01
89-118	PERMETHRIN	SPRUCE (COMMERCIAL WOODLANDS)	ON	03 PESTICIDES	1989.11.06	1989.12.15
89-119	PERMETHRIN	BALSAM FIR ON	ON	03 PESTICIDES	1989.11.06	1989.12.15
89-120	PERMETHRIN	DECIDUOUS & CONIFEROUS TREES	ON	03 PESTICIDES	1989.11.06	1989.12.15
89-207	IPRODIONE	CONIFER SEEDLINGS (GREENHOUSE)	BC	03 PESTICIDES	1989.10.04	1990.06.01
89-206	BENOMYL	CEDAR	ON	12 REGISTRANT	1990.05.22	1990.08.30
90-112	OXYDEMETON-METHYL	DOUGLAS-FIR, SPRUCE & CEDAR (COMMERCIAL WOODLANDS)	BC	03 SIRS	1990.06.08	1990.08.30
90-211	BENOMYL	AUSTRIAN & RED PINE	ON	08 EFFICACY TRIAL	1990.05.29	1990.08.30
90-500	SIMAZINE	SPRUCE & RED PINE	PQ	01 ON HOLD	1989.12.27	1990.04.01
90-540	MINERAL OIL	CONIFER SEEDLINGS	ON	03 PESTICIDES	1990.02.15	1990.04.01
90-553	GLYPHOSATE	DECIDUOUS TREES	PQ	03 PESTICIDES	1990.05.29	1990.08.30
90-556	CLOPYRALID	BALSAM FIR	NB	03 PESTICIDES	1990.07.16	1990.08.30

REGISTERED FOR USE UNDER THE MINOR USE OF PESTICIDES PROGRAM

Prepared by Coordinators' Office, SIRS
Sept. 21, 1990/Updated Nov. 1990

SUB. #	ACTIVE INGREDIENT	HOST(S)	PEST(S)	DATE
78-001A	Benomyl	Aspen and	Marssonina leaf spot and	11.01.84
78-001B	Benomyl	Poplar	Septoria leaf spot	11.01.84
78-004	Benomyl	Lima bean	White mold	05.03.80
78-006A	Thiophanate-methyl	Aspen and	Marssonina leaf spot and	13.10.82
78-006B	Thiophanate-methyl	Poplar	Septoria leaf spot	13.10.82
79-002A	Copper oxychloride	Flowering Prunus spp.	Coryneum blight; bacterial canker (Pseudomonas syringae)	16.11.81
79-002B	Copper oxychloride	Forsythia, lilac, rose	Bacterial blight (P. syringae)	16.11.81
79-003A	Benomyl	Clematis	Stem rot	06.08.82
79-003B	Benomyl	Willow	Willow blight (Marssonina spp.)	06.08.82
80-005	Phosmet	Lowbush blueberry	Blueberry maggot	10.05.82
80-006	Dimethoate	Lowbush blueberry	Blueberry maggot	04.06.82
80-011	Permethrin	Lowbush blueberry	Thrips	04.10.82
80-012	Methomyl	Snap beans	Corn borer	06.02.83
80-516	Trifluralin	Sainfoin	Annual grasses and Broadleaf weeds	02.11.87
81-002	Monosodium methanearsonate	Pinus contorta	Dendroctonus ponderosae	11.02.82
81-003	Malathion/pyrethrin/ piperonyl butoxide	Mushroom	Mushroom fly (Sciarid fly)	04.08.83
81-005	Cyhexatin	Raspberry canes	Two spotted spider mite	07.05.86
81-006	Disulfoton	Asparagus	Asparagus aphid	20.02.87
81-009	Phosmet	Beef cattle	Rocky Mountain Wood Tick	26.05.82

SUB. #	ACTIVE INGREDIENT	HOST(S)	PEST(S)	DATE
81-010	Copper oxychloride	Onion	Downy mildew	29.12.81
81-011	Copper oxychloride	Raspberry	Bacterial blight	10.05.82
81-018	Methomyl	Apple	Mullein leaf bug	22.07.82
81-024	Bacillus thuringiensis	Cranberry	Green & Brown span worms	10.11.82
81-026	Thiophanate-methyl	Blueberry	Blossom and Twig blight	10.11.82
81-027	Triforine	Blueberry	Mummyberry	13.10.82
81-028	Dimethoate	Spruce	Cone & Seed insects	24.08.82
81-029	Fenvalerate	Peanut	Potato leafhopper	04.06.82
82-002	Trichlorfon	Coniferous trees	Spruce budmoths	02.06.82
82-003	Aminocarb	Coniferous trees	Spruce budmoths	02.06.82
82-004	Fenitrothion	Coniferous trees	Spruce budmoths	02.06.82
82-005	Bacillus thuringiensis	Coniferous trees	Spruce budmoths	31.07.82
82-006	Benomyl	Asparagus	Fusarium rot, Rhizoctonia & Violet root rot	09.08.82
82-008	Permethrin	Chrysanthemum	Chrysthanthemum leafminer	03.02.83
82-009	Chlorpyrifos	Ornamentals	Mealybug	17.09.82
82-010	Dimethoate bran bait	Field crops	Grasshoppers	01.03.85
82-011A	Kinoprene	Greenhouse ornamentals	Mealybugs, Fungus gnats, Soft and Armored scales	11.02.83
82-011B	Kinoprene	Vegetable seed crops	Mealybugs, Fungus gnats, Soft and Armored scales	11.02.83
82-012	Pirimicarb	Lettuce	Lettuce aphid, Green peach aphid, Potato aphid, and Foxgloce aphid	24.03.83
82-503	Linuron	Saskatoon	Annual grasses and Broadleaf weeds	15.06.87
82-504	Trifluralin	Sweet clover seedlings	Annual grasses and Broadleaf weeds	20.12.88

SUB. #	ACTIVE INGREDIENT	HOST(S)	PEST(S)	DATE
83-001	Dimethoate	Apple	Codling moth	15.04.83
83-002	Monosodium methane arsonate	Spruce	Spruce beetle (Dendroctonus rufipennis)	30.03.83
83-005	Bacillus thuringiensis	Apple	Fruittree leafroller	03.05.83
83-008	Diazinon	Greenhouse chrysanthemum	Chrysanthemum leafminer	22.03.83
83-009	Maneb	Sugar beet	Damping-off diseases (Phoma & Pythium)	14.06.83
83-014	Bromadiolone	Residential buildings	Squirrels	28.04.86
83-020B	Terbufos	Rutabaga	Cabbage maggot and Flea beetles	25.05.88
83-024	Soap	Elm (English & Scotch)	Elm leafminer	13.07.83
83-025	Permethrin	Lentils	Pale western cutworm and Redbacked cutworm	22.01.87
83-027	Dimethoate	Asparagus	Asparagus aphid	20.08.84
83-028	Pirimicarb	Asparagus	Asparagus aphid	11.08.84
83-029	Thiophanate-methyl/ diazinon	Potato	Silver scurf	02.11.87
84-005	Azinphosmethyl	Melon, pumpkin, squash	Cucumber beeetles	05.07.84
84-006	Phosmet	Celery	Carrot weevil	31.05.88
84-008	Cypermethrin	Lettuce	Aster leafhopper	12.10.88
84-010	Dimethoate	Eggplant	Tarnished plant bug	04.08.87
84-011	Permethrin	Conifer seedlings	Cutworms	26.02.85
84-012	Fenvalerate	Conifer seedlings	Strawberry root weevil	09.09.85
84-013	Streptomycin sulfate	Brassica crops	Xanthomonas campestris	18.09.85
84-014	Permethrin	Apple	Synanthedon bark borer	01.05.84
84-018	Bacillus thuringiensis	Sunflower	Sunflower moth and Banded sunflower moth	02.12.85

SUB. #	ACTIVE INGREDIENT	HOST(S)	PEST(S)	DATE
84-019	Methomyl	Apple	Oblique banded leafroller	13.02.85
84-020	Chlorpyrifos	Cabbage, cauliflower, broccoli seedlings	Cabagge maggot	13.02.85
84-021	Malathion	Wild rice	Wild riceworm	15.06.87
84-024	Oxamyl	Raspberry	Root lesion nematode	24.03.87
84-025	Permethrin	Asparagus	Cutworms	05.05.87
84-026	Salts of higher fatty acids/ammonia	Berry crops	Deer	23.04.85
84-027	Dicofol	Pear	Pear rust mite	06.03.85
84-028	Demeton	Apple	Potato leafhopper	13.03.85
85-001	Fenvalerate	Conifer seedlings and ornamentals	Root weevils	18.04.86
85-003	Streptomycin	Beans	Bacterial blight	18.09.85
85-004	Methomyl	Brussels sprouts	Slugs	06.01.86
85-007A	Chlorpyrifos	Brussels sprouts	Cabbage maggot	15.07.86
85-007B	Chlorpyrifos	Rutabaga	Cabbage maggot	15.07.86
85-011	Oxydemeton-methyl	Asparagus	Asparagus aphid	24.02.87
85-012	Disulfoton	Iceberg lettuce	Lettuce aphid	31.10.85
85-013	Disulfoton	Asparagus	Asparagus aphid	20.02.87
85-014	Carbaryl	Blueberries	Leafrollers and spanworms	13.01.86
85-015	Mancozeb	Juniperous spp.	Gymnosporangium fuscum	12.11.85
85-016	Malathion	Lentil	Grasshoppers	12.04.89
85-018	Carbofuran	Sugar beet	Sugarbeet root maggot	07.03.89
85-019	Methomyl	Greenhouse cucumbers	Western flower thrips	06.01.86
85-020	Mineral oil	Greenhouse cucumber and greenhouse tomato	Greenhouse whitefly	21.04.86

SUB. #	ACTIVE INGREDIENT	HOST(S)	PEST(S)	DATE
85-022	Dimethoate	Safflower	Grasshoppers	04.06.87
85-025	Metiram	Apple	Quince rust	26.02.86
85-026	Mancozeb	Apple	Quince rust	10.02.86
86-002A	Bendiocarb	Greenhouse ornamentals	Western flower thrips, mealybugs, scale insects, fungus gnats, whitefly and aphids	25.07.86
86-002B	Bendiocarb	Interior Plantscapes	Thrips, mealybugs, scale insects, fungus gnats, whitefly and aphids	12.03.90
86-003A	Deltamethrin	Greenhouse ornamentals	Western flower thrips	07.07.86
86-004	Metalaxyl	Hops	Downy mildew	12.03.90
86-009	Chlorpyrifos	Lodgepole pine	Mountain pine beetle (Dendroctonus pondersae)	16.01.87
86-010	Carbaryl	Lodgepole pine	Mountain pine beetle (Dendroctonus pondersae)	20.02.87
86-011	Sulphur	Greenhouse cucumber	Powdery mildew (Sphaerotheca fuliginea)	09.06.86
86-013	Iprodione	Ginseng	Alternaria leaf blight	11.08.86
86-014	Mancozeb	Ginseng	Alternaria leaf blight	01.06.87
86-015	Anilazine	Ginseng	Alternaria leaf blight	30.06.86
86-016	Methomyl	Strawberry	Slugs	06.01.88
86-017	Mineral oil	Rutabaga	Green peach aphid	05.06.86
86-018	Ferbam	Spruce cones	Spruce cone rust	19.05.87
86-019	Oxydemeton-methyl	Douglas-fir cones	Cone and seed insects	24.02.87
86-022	Copper oxychloride	Highbush blueberry	Bacterial blight	16.11.86
86-026	Dimethoate	Canaryseed	Aphids	04.08.87
86-027	Malathion	Canaryseed	Aphids	15.06.87

SUB. #	ACTIVE INGREDIENT	HOST(S)	PEST(S)	DATE
86-029	Gamma BHC-carbathiin-thiram	Cole crops	Flea beetles	05.05.87
86-030	Gamma BHC-carbathiin-thiram	Rutabaga	Flea beetles	05.05.87
86-501	Trifluralin (Extension of Eastern/BC label to all Canada)	Asparagus	Annual Grasses and Annual Broadleaf Weeds	02.11.87
86-502	Trifluralin	Strawberry	Broadleaf weeds	02.11.87
86-503A	Metribuzin	Asparagus	Weed control	31.03.88
86-506	Sethoxydim	Garlic	Grasses	02.11.87
86-507	Trifluralin	Siberian elm	Germinating Annual grasses and Broadleaf weeds	08.12.87
86-508	Linuron	Chokecherry	Annual grasses and Annual Broadleaf weeds	15.06.87
86-509	Chloroxuron	Poplar, Willow	Selective weed control	28.10.88
86-510	Trifluralin	Fall rye, Fall triticale, Winter Wheat	Weed control	11.12.87
87-001	Iprodione	Conifer seedlings	Botrytis	04.03.88
87-004	Anilazine	Blueberry	Anthracnose (Glomerella cingulata)	03.09.87
87-005	Cypermethrin	Conifer nursery seedlings (outdoors)	Tarnished plant bug	26.05.89
87-006	Chlorpyrifos	Garlic	Onion maggot	30.05.88
87-501	Simazine	Peach, Apricot, Apple trees	Annual weeds	26.05.89
87-503	Metribuzin	Cherry, apple, peach, apricot tree	Annual weeds	12.12.88
87-507	Metribuzin	Processing peas	Broadleaved weeds	30.01.90
87-513	Simazine	Container nursery stock	Broadleaved weeds	26.05.89
87-515	Phenmedipham	Table beet	Broadleaved weeds	21.07.89
87-516	Phenmedipham	Table beet	Broadleaved weeds (two applications)	21.07.89

SUB. #	ACTIVE INGREDIENT	HOST(S)	PEST(S)	DATE
89-506	Bentazon	Seedling forage legumes (for seed)	Weeds	27.07.89
89-507	Diclofop-Methyl/Bromo	Forage Grasses	Weeds	21.02.90
89-554	Ethalfluralin	Safflower	Weeds	26.05.89
89-563	Hexazinone	Alfalfa for Seed	Weeds	26.07.90
89-565	Ethalfluralin	Seedling alfalfa (for seed)	Weeds	26.05.89
89-568	Clopyralid	Seed timothy	Weeds	17.04.89
89-578	Glyphosate	Apricot tree, new	Weeds	01.03.89
89-596	Ethalfluralin	Spices (Dill, Caraway, Coriander)	Weeds	26.05.89
89-597	Sethoxydim	Spices (Dill, Caraway, Coriander)	Grassy weeds	25.08.89
89-600	Metolachlor	Snap beans	Broadleaved weeds	03.07.90
89-605	Napropamide	Asparagus (Seedlings & new planting)	Broadleaved weeds & grasses	23.01.90
89-607	Glyphosate	Highbush blueberry	Quackgrass	13.10.89
90-110	Chlorpyrifos	Sunflower	Sunflower seed weevil	31.08.90
90-546	Glyphosate	Filberts/Hazelnuts	Weed control	17.07.90
90-549	Fluazifop-butyl	Creeping red fescue	Weeds	17.05.90
90-550	Fluazifop-p-butyl	Creeping red fescue	Weeds	17.05.90

SUB. #	ACTIVE INGREDIENT	HOST(S)	PEST(S)	DATE
88-100	Diazinon	Greenhouse pepper	Aphids	30.06.90
88-103	B. thuringiensis	Greenhouse pepper	Cabbage looper	19.04.89
88-115	Dimethoate	Cabbage	Thrips	23.03.89
88-116	Dimethoate	Cauliflower	Thrips	23.03.89
88-117	Dimethoate	Broccoli	Thrips	23.03.89
88-130	Cypermethrin + B. thuringiensis	Apple	Winter moth	27.04.89
88-102	Safer's Insecticidal Soap Concentrate	Greenhouse pepper	Aphids	04.11.88
88-106	Cypermethrin	Onion	Thrips	21.10.88
88-109	Cypermethrin	Cabbage	Thrips	12.10.88
88-110	Cypermethrin	Cauliflower	Thrips	12.10.88
88-111	Cypermethrin	Broccoli	Thrips	12.10.88
88-112	Cypermethrin	Brussels sprouts	Thrips	12.10.88
88-114	Methomyl	Sweet corn	Aphids	12.10.88
88-209	Iprodione	Garlic	Green mold decay	10.07.89
88-502	Clopyralid	Strawberries	Weeds	21.07.89
88-505	Picloram/2,4-D	Forage grasses (seeds)	Volunteer Alsike clover	10.07.89
88-506	Trifluralin	Safflower	Annual weeds	20.01.89
88-508	Trifluralin	Forage kale	Annual weeds	15.02.89
88-509	Trifluralin	Forage rape	Annual weeds	15.02.89
88-510	Trifluralin	Stubble turnip	Annual weeds	15.02.89
88-515	Linuron	Sweet white lupin	Broadleaved weeds	16.05.90
88-517	Metribuzin	Sweet white lupin	Broadleaved weeds	17.09.90
88-519	Trifluralin	Carrots	Annual weeds	20.01.89
88-520	Trifluralin	Snap beans	Annual weeds	20.01.89
88-521	Trifluralin	Cauliflower	Annual weeds	20.01.89
88-522	Trifluralin	Cabbage	Annual weeds	20.01.89

SUB. #	ACTIVE INGREDIENT	HOST(S)	PEST(S)	DATE
88-523	Trifluralin	Rutabaga	Annual weeds	20.01.89
88-524	Trifluralin	Tomatoes	Annual weeds	20.01.89
88-525	Trifluralin	Broccoli	Annual weeds	20.01.89
88-526	Trifluralin	Brussels sprouts	Annual weeds	20.01.89
88-527	Trifluralin	Peppers	Annual weeds	20.01.89
88-511	2,4-D + Dichlorprop	Wheat	Toadflax (suppression)	04.11.88
88-512	2,4-D + Dichlorprop	Barley	Toadflax (suppression)	04.11.88
89-110	Oxydemeton-methyl	Strawberries	Aphids	21.07.89
89-112	Permethrin	Horseradish	Flea beetles	02.06.89
89-113	B. thuringiensis	Apricots	Leafrollers	26.05.89
89-114	B. thuringiensis	Cherries	Leafrollers	26.05.89
89-115	B. thuringiensis	Peaches	Leafrollers	26.05.89
89-116	B. thuringiensis	Pears	Leafrollers	26.05.89
89-117	B. thuringiensis	Prunes & Plums	Leafrollers	26.05.89
89-121	Carbaryl	Lupins	Blister beetles, grasshoppers	19.09.89
89-205	Benomyl	Carrots	Sclerotinia white mold	02.03.90
89-206	Sulphur	Cucumber (Greenhouse)	Powdery mildew	10.07.89
89-207	[illegible]	[illegible] (Greenhouse)	[illegible]	[illegible]
89-500	Diclofop-methyl	Seedling alsike clover, sainfoin (seed production)	Weeds	19.04.89
89-501	Sethoxydim	Established forage legumes (for seed)	Grassy weeds	27.07.89
89-503	Sethoxydim	Seedling forage legumes (for seed)	Grassy weeds	27.07.89
89-505	Bentazon	Seedling forage legumes (for seed)	Weeds	27.07.89

B.t. Registrations FORESTRY USE - 1990

PRODUCT	REGISTRANT	POTENCY (B.I.U./litre)	PEST	RATE (B.I.U./ha)
Foray 48B	NOVO	12.7	Eastern Spruce Budworm	20-30
			Gypsy Moth	30-50
			Forest Tent Caterpillar	8-20
Dipel 64AF	ABBOTT	16.9	Eastern Spruce Budworm*	15-30
			Gypsy Moth	30-50
Futura XLV-HP	Duphar	33	Eastern Spruce Budworm*	15-30
BIODART	ICI-Forest Products	16.9	Eastern Spruce Budworm*	15-30
Futura XLV	Duphar	14.8	Eastern Hemlock Looper*	30

* Temporary registration.

Agriculture
Canada

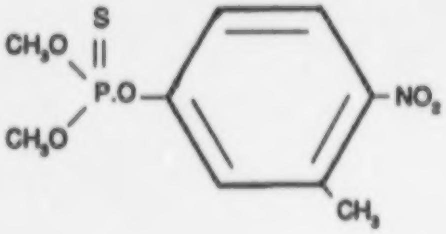
Direction générale de la production et de l'inspection des aliments
Direction des pesticides

Food Production and Inspection Branch
Pesticides Directorate

Canada
90-03

Avis

FÉNITROTHION



INSECTICIDE

DIVISION DE LA GESTION DES PRODUITS

LE 17 OCTOBRE 1990

Ce bulletin d'information est préparé par le Secrétariat à l'information de la Direction des pesticides. Pour de plus amples renseignements, veuillez contacter :

Direction des pesticides
Agriculture Canada
Ottawa (Ontario)
K1A 0C6
(613) 993-4544
Facsimile : (613) 998-1312
Telex : 053-3282
Envoy 100 : Pesticide
Réseau national de renseignements sur les pesticides : 1-800-267-6315

This bulletin is published by the Information Secretariat of the Pesticides Directorate. For further information, please contact:

Pesticides Directorate
Agriculture Canada
Ottawa, Ontario
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Facsimile: (613) 998-1312
Telex: 053-3282
Envoy 100: Pesticide
National Pesticide Call-Line: 1-800-267-6315

EXAMEN SPÉCIAL DU FÉNITROTHION

L'objet de la présente annonce est d'informer les titulaires d'homologation, les agents de réglementation des pesticides et les autres personnes concernées ou intéressées que les produits homologués renfermant du fénitrothion font actuellement l'objet d'un examen en vertu des dispositions de l'article 19 du Règlement sur les produits antiparasitaires. L'examen portera sur les effets environnementaux du fénitrothion lorsqu'on le pulvérise sur les forêts, et il comprendra une évaluation de la valeur du produit. Les études sur la toxicité pour les mammifères, autres que celles portant sur les effets possibles du produit sur la faune naturelle (c.-à-d. à l'exclusion de l'homme), ne seront pas prises en considération à ce stade-ci.

JUSTIFICATION

En mars 1989, Environnement Canada a publié une vaste revue de la littérature intitulée Les effets environnementaux de l'utilisation de fénitrothion en foresterie (Environnement Canada, Conservation et protection, Région de l'Atlantique).

L'étude d'Environnement Canada concluait que "la pulvérisation à grande échelle du fénitrothion aux taux homologués n'était pas souhaitable du point de vue environnemental" et recommandait que l'on procède sans délais à une réévaluation des emplois homologués du fénitrothion en exploitation forestière.

Parmi les inquiétudes soulevées dans le rapport, mentionnons :

a) l'incidence sur les espèces d'insectes pollinisateurs et sur les processus écologiques connexes;

b) les effets directs sur les oiseaux chanteurs des forêts, ainsi que les effets indirects possibles sur le taux de reproduction de ces derniers; et,

c) les effets sur les invertébrés aquatiques.

Du point de vue des pêches, l'information touchant l'incidence du fénitrothion sur les systèmes aquatiques a mené à la conclusion générale qu'une toxicité directe pour le poisson est improbable. Toutefois, les éléments réunis jusqu'ici révèlent que l'emploi du fénitrothion dans les écosystèmes forestiers pourrait réduire les populations d'invertébrés aquatiques. On sait que ces derniers servent de nourriture aux poissons, mais l'incidence de leur destruction partielle sur ces derniers demeure incertaine.

En aménagement forestier, le fénitrothion a été utilisé par les responsables provinciaux et privés de la lutte antiparasitaire dans des campagnes conçues pour réduire la défoliation et la mortalité des arbres causées par les insectes, en particulier la tordeuse de l'épinette et l'arpenteuse de la pruche de l'Est. Bien que son emploi ait diminué ces dernières années, le fénitrothion est demeuré une arme importante dans l'arsenal de lutte.

PRÉSENTATION DES DONNÉES

Les besoins en études et en données pour cet examen spécial ont été déterminés de concert avec les organismes consultatifs d'Agriculture Canada, c'est-à-dire Environnement Canada, Forêts Canada et Pêches et Océans Canada.

EXIGENCES RELATIVES AUX DONNÉES

1. Information générale

1.1 Organisation des données

Toutes les données soumises doivent être organisées conformément à la circulaire à la profession T-1-237 d'Agriculture Canada (1er octobre 1983) pour ce qui est des matières actives techniques et de leurs principaux métabolites et produits de transformation, et conformément à la circulaire à la profession T-1-239 (1er octobre 1983) pour ce qui est des produits prêts à l'emploi. La portée de cette réévaluation se limite uniquement aux parties 0 (Index), 1 (étiquettes), 2 (Chimie), 6 (Chimie dans l'environnement), 7 (Toxicologie environnementale) et 8 (Efficacité) ou un rapport sur les avantages intégrant la partie 8. Les sections de la partie 3 (Toxicologie) peuvent être exigées, mais il n'est pas nécessaire de les soumettre à moins qu'on n'en fasse spécifiquement la demande

1.2 Nouvelle présentation des études

Les données soumises avant 1980 ne seront pas prises en considération à moins qu'elles ne soient présentées de nouveau. Les sociétés devront présenter de nouveau les données anciennes pertinentes qu'elles désirent voir entrer en ligne de compte; elles pourraient aussi être invitées à présenter de nouveau certaines études à un stade ultérieur du processus de réévaluation. Il ne sera pas nécessaire de présenter de nouveau les données fournies après 1980 et organisées conformément aux circulaires T-1-237 et T-1-239.

2. Études pertinentes pour la présente réévaluation

2.1 Index

Les titulaires d'homologation seront invités à mettre à jour et à soumettre un index de l'ensemble de leurs propres études portant sur le fénitrothion technique et ses principaux métabolites et produits de transformation, organisé conformément à la circulaire T-1-237, et un index de tous les produits prêts à l'emploi du fénitrothion, organisé conformément à la circulaire T-1-239.

Lorsque cela est possible, l'index doit distinguer entre les études qui 1) sont soumises pour la première fois; 2) ont été soumises depuis 1980; 3) sont présentées de nouveau; et 4) sont jugées non pertinentes et, pour cette raison, ne sont pas soumises à ce stade-ci.

2.2 Étiquettes

Les titulaires d'homologation seront invités à soumettre les étiquettes de tous leurs produits homologués (y compris les produits techniques) renfermant du fénitrothion.

2.3 Chimie du produit

Les exigences en matière d'échantillons, de spécifications et de méthodes d'analyse à l'appui de l'homologation des matières actives techniques sont décrites dans la circulaire T-1-238; dans le cas des produits formulés, ces exigences figurent dans la circulaire T-1-240.

2.4 Chimie et devenir dans l'environnement

Les exigences actuelles relatives aux données sur la chimie et le devenir dans l'environnement figurent dans la circulaire à la profession T-1-255 d'Agriculture Canada (Guide de chimie et de devenir des pesticides dans l'environnement, 30 septembre 1987) et dans la partie 6 des circulaires T-1-237 et 239. Comme les sciences de la chimie et du devenir dans l'environnement ont évolué rapidement, toutes les études disponibles touchant ces aspects pourront être considérées pertinentes par Environnement Canada et, par conséquent, devraient être soumises. Les études n'ont pas à se conformer aux exigences de la circulaire T-1-255 pour être admissibles.

2.5 Toxicologie environnementale

Les lignes directrices canadiennes sur les exigences relatives aux données de toxicologie environnementale n'ont pas encore été élaborées. Toutes les études, en particulier les travaux sur le terrain (peu importe l'endroit), sont considérées pertinentes par le Service canadien de la faune d'Environnement Canada et doivent être soumises. Elles n'ont pas à se conformer aux lignes directrices actuelles de l'EPA, aux États-Unis, ni à celles de l'Organisation pour la coopération et le développement économiques (OCDE) pour être prises en considération. On invite les titulaires à passer en revue les recommandations précises et les préoccupations mentionnées dans Les effets environnementaux de l'utilisation du Fénitrothion en foresterie, publié par la Direction générale de la conservation et de la protection d'Environnement Canada, Région de l'Atlantique, et à discuter des besoins particuliers en données avec Environnement Canada.

2.6 Information sur les avantages et sur l'efficacité

On élabore en ce moment les lignes directrices sur les besoins en données. Toutes les études sont considérées pertinentes. Les titulaires et les autres parties intéressées peuvent communiquer avec la Direction des pesticides pour obtenir plus de renseignements.

3. Autres informations exigées

3.1 Données sur les incidents

Les titulaires doivent, dans la mesure du possible, fournir les données sur les incidents ou les rapports non publiés touchant les empoisonnements, les cas d'exposition excessive par un utilisateur ou un spectateur, ou encore tout autre risque sanitaire, la contamination des approvisionnements en eau, les déversements, les accidents ou encore les problèmes causés à la faune par le fénitrothion.

3.2 Situation réglementaire ailleurs dans le monde

On demande aux fabricants de la matière active et aux propriétaires des données de fournir un rapport récapitulatif de la situation réglementaire du fénitrothion dans les autres pays, et de toutes les mesures réglementaires qui ont été prises à son sujet.

3.3 Données publiées

L'examen spécial prendra en considération les études publiées. Ce processus commencera par l'examen d'une bibliographie des études publiées intéressant le fénitrothion (produit technique, produits prêts à l'emploi et principaux métabolites et produits de transformation), laquelle devra être accompagnée d'une description des bases de données et autres méthodes utilisées pour recenser la littérature publiée.

Il y a lieu d'annoter la bibliographie en incluant les résumés fournis par les auteurs ou par le fabricant de la matière active, et d'indiquer la source de ces annotations (auteur original ou fabricant). La bibliographie devrait être organisée selon les principales parties (et non les sous-parties) décrites dans la circulaire T-1-237, et comprendre des renvois, de façon à éviter les doubles emplois. Chaque fabricant de la matière active ou propriétaire de données est tenu de fournir une telle bibliographie dans les trois mois suivant la publication de la présente annonce, mais l'industrie jugera peut-être bon d'adopter une approche de groupe afin de partager le coût de l'établissement des bibliographies.

4. Besoins initiaux en information - fénitrothion technique et produits prêts à l'emploi (formulations renfermant du fénitrothion)

Chaque fabricant de la matière active ou propriétaire de données est tenu de soumettre dans les trois mois de la date de la présente annonce:

4.1 neuf exemplaires d'un index de toutes les études propres touchant le fénitrothion technique et ses principaux métabolites et produits de transformation, organisé conformément à la circulaire T-1-237;

4.2 pour chaque produit, neuf étiquettes à jour ou fac-similés de celles-ci;

4.3 huit exemplaires des données sur la chimie du produit;

4.4 six exemplaires de toutes les études pertinentes qui leur sont propres touchant la chimie et le devenir dans l'environnement et la toxicologie environnementale, sauf celles qui ont été soumises depuis 1980;

4.5 trois exemplaires des rapports sur les avantages et l'efficacité;

4.6 six exemplaires des rapports sur les incidents sur la situation réglementaire ailleurs dans le monde, et six exemplaires de la bibliographie des études publiées.

PROTOCOLE DE RÉÉVALUATION

1. Les données soumises seront distribuées par Agriculture Canada à ses organismes consultatifs (Environnement Canada, Pêches et Océans Canada et Forêts Canada), pour examen.

2. Les lacunes des données et de l'information seront cernées et signalées aux titulaires d'homologation.

3. Les titulaires pourront être invités à fournir de nouvelles études ou des études de remplacement.

4. Les données privées soumises dans le cadre de cette évaluation et jugées valides seront reconnues conformément à la politique d'homologation spécifique par produit d'Agriculture Canada.

5. Il incombe aux fabricants du fénitrothion et aux titulaires d'homologation des produits prêts à l'emploi pertinents d'élaborer et de fournir un dossier technique à l'appui de leurs produits. Les autres parties intéressées peuvent soumettre de l'information technique pertinente après consultation avec la Direction des pesticides. L'industrie jugera peut-être bon d'adopter une approche de groupe afin de partager le coût de l'établissement des données.

6. Dans le cadre du processus de consultation, les titulaires d'homologation, les utilisateurs, les groupes d'intérêts et les autres parties intéressées auront l'occasion de formuler leurs commentaires sur toute révision proposée à la situation réglementaire des produits contenant du fénitrothion.

PROFIL D'EMPLOI

On trouvera en annexe à la présente circulaire un résumé des emplois forestiers du fénitrothion à la lumière des étiquettes homologuées en vertu de la Loi sur les produits antiparasitaires. On demande aux titulaires d'homologation d'examiner ce résumé et de vérifier s'il reflète complètement et fidèlement les instructions figurant sur leurs étiquettes homologuées.

Tout titulaire qui désire proposer des suppressions ou des révisions à ce résumé des emplois doit communiquer avec la Direction des pesticides dans les trois mois suivant la date de la présente circulaire.

Prière d'envoyer les données et toute correspondance à:

R. Lidstone
Direction des pesticides
Agriculture Canada
2^{e} étage. Édifice SBI
2323, Promenade Riverside
Ottawa (Ontario)
K1A 0C5

Les emplois du Fénitrothion (FEM)
en exploitation forestière

LIMITATIONS MENTIONNÉES DANS LES EMPLOIS SUIVANTS:

1. Utiliser au plus 280 g/ha pour une seule application ou un total de 420 g/ha en deux traitements.
2. NATURE DE LA RESTRICTION : Ce produit ne doit être utilisé que de la manière autorisée; consulter les autorités locales chargées de la réglementation des pesticides au sujet des permis qui peuvent être exigés.
3. Ne mélanger avec aucun produit, si ce n'est ceux figurant sur l'étiquette enregistrée.

BOISÉS

Arpenteuse de la pruche de l'Est, arpenteuse d'automne, tordeuse du pin gris, tenthrèdes, tordeuse de l'épinette, arpenteuse de la pruche de l'Ouest.

> 140 - 280 g/ha de concentré émulsifiable
> APPLICATION TERRESTRE : Appliquer sous forme de pulvérisation à faible ou ultra-faible volume ou encore en émulsion dans suffisamment d'eau pour assurer un bon traitement. Procéder à une seule application de 280 g/ha ou à deux applications de 150-200 g/ha à 4 ou 6 jours d'intervalle. Pour l'arpenteuse de la pruche, appliquer avant le quatrième stade larvaire. Dans le cas de la tordeuse du pin gris, appliquer entre les troisième et sixième stades larvaires. Pour ce qui est des tenthrèdes ou des arpenteuses d'automne, appliquer dès que la larve apparaît. Pour les diprions du pin gris, appliquer au pic d'émergence du deuxième stade larvaire. Pour la tordeuse de l'épinette, appliquer aussitôt que des insectes sont signalés et répéter le traitement environ une semaine plus tard juste avant le pic du quatrième stade larvaire. Le traitement décrit plus haut pour la tordeuse des bourgeons de l'épinette est également efficace contre les adultes.
> Limitations : (1) (2)

FORÊT

Arpenteuse de la pruche de l'Est, arpenteuse d'automne, tordeuse du pin gris, tenthrèdes, tordeuse du bourgeon de l'épinette, arpenteuse de la pruche de l'ouest.

LIMITATION : 140 - 280 g/ha de concentré émulsifiable
APPLICATION AÉRIENNE OU TERRESTRE: Appliquer sous forme de pulvérisation à faible ou ultra-faible volume ou encore en émulsion dans suffisamment d'eau pour assurer un bon traitement. Procéder à une seule application de 280 g/ha ou à deux applications de 140-210 g/ha à 4 ou 6 jours d'intervalle. Pour l'arpenteuse de la pruche, appliquer avant le quatrième stade larvaire. Dans le cas de la tordeuse du pin gris, appliquer entre les troisième et sixième stades larvaires. Pour ce qui est des tenthrèdes ou des arpenteuses d'automne, appliquer dès que la larve apparaît. Pour les diprions du pin gris, appliquer au pic d'émergence du deuxième stade larvaire. Pour la tordeuse de l'épinette, appliquer aussitôt que des insectes sont signalés et répéter le traitement environ une semaine plus tard juste avant le pic du quatrième stade larvaire. Le traitement décrit plus haut pour la tordeuse des bourgeons de l'épinette est également efficace contre les adultes.
Limitations : (1) (2) (3)

0022k

Agriculture
Canada

Food Production
and Inspection Branch

Direction générale,
Production et inspection des aliments

Pesticides Directorate
Ottawa, Ontario
K1A 0C6
TEL: (613) 993-4544
FAX: (613) 998-1312

Your file Votre référence

Our file Notre référence

November 20, 1990

MEMORANDUM TO: Interested Parties

RE: Efficacy Evaluation of Microbial (B.t.) Products for use in forestry. Summary of Quebec City meeting, April, 1990

Enclosed are the discussion agenda, participants list, conclusions/recommendations and action plan arising from our meeting in Quebec City to discuss issues related to evaluation and field testing of B.t. products for registration.

The discussion agenda was based on our previous meeting in November 19, 1989 and on comments received in response to the minutes of the Ottawa meeting. Major recommendations and actions included:

- establishment of a committee to develop protocols and to evaluate efficacy and related data.
- establishment of a framework for review/approval of testing protocols prior to initiation of field research.
- clarification of minimum criteria for registration of new strains, formulations (basic laboratory data; field efficacy data required for registration on a major pest).

Issues related to documentation, reporting of data, labelling and registration on "minor" pests were also discussed.

I want to thank all those who participated in this initiative through submission of comments and/or attendance at the meeting. Your comments and efforts are welcome and appreciated.

Current activity and future directions will be discussed in detail at a meeting on November 22, 1990 (in association with the Forest Pest Control Forum) in Ottawa.

Jean E. Irvin, Ph.D.
Product Manager
Biological Pesticides
Product Management Division

JEI/jed
0985f

DISCUSSION AGENDA - EVALUATION OF B.T. PRODUCTS

QUEBEC CITY, APRIL 3-4, 1990.

Issues, Discussion points relevant to the assessment of efficacy, merit, value of B.t. products for regulatory purposes (based on comments received and previous discussions).

I. LABORATORY/GREENHOUSE EVALUATION

- product potency
- dose/mortality relationship
- foliar persistence
- physical properties
- determination of host range
- strain/endotoxin identification
- etc.?

Goal: 1. Define appropriate criteria.
2. Describe acceptable lab/greenhouse/small plot techniques to evaluate product at this level.

Are there circumstances in which this level of testing would be sufficient for product registration?

II. FIELD EVALUATION

A. *General Issues/Questions*

1. Definition of efficacy (e.g. foliage protection, population reduction). Will this change as a function of target pest?

2. Trial criteria - what constitutes a good trial, one that would be acceptable to support a product registration?

3. Definition of minimum requirements for registration. Do we require 'scientifically correct assessments' (replication) in addition to 'semi-operational' tests (i.e. not replicated)? How are these defined?

4. Is it neccessary to conduct trials over a two year period in order to obtain product approval?

5. Trial numbers - How many 'successful' trials are required to support product registration?

6. Should the same minimum requirements apply to "minor" pests (e.g. Forest Tent Caterpillar, Blackheaded Budworm, Hemlock Looper, Cankerworms, etc.)?

7. Are U.S. data acceptable with or without supplementary Canadian data? Should there be an attempt to harmonize protocols, testing approaches with U.S.?

B. Development of Uniform Protocols

1. Define parameters to be monitored.

2. Define methods.

3. Pest specific recommendations?

List of suggested parameters and factors to be included:

- use of replicates
- prespray and postspray counts
- intermediate counts
- sampling
- description of application equipment
- measure of deposit
- dose response relationships
- defoliation measure
- development of insects
- development of trees
- sampling
- amount of damage on trees prior to test - estimate damage on spray day
- topography
- weather parameters - define optimum?
- application specifications
- persistence measures
- inclusion of positive control?
- size of treatment blocks
- assay of test formulation prior to spray?
- data analysis (including control data)

III. Documentation/Reporting of Data

1. Define what is required in report; how to present

2. GLP?

Suggestions re: information required

- name of cooperator
- geographic location
- test site location
- size of test blocks
- product applied, dosage, volume, emission rate, application date, hardware used
- assessment methodology, assessment dates, synopsis of results, etc.
- additional information in appendices?
- provide overall summary of tests

Goal: Standardize format of data presentation.

IV. Labelling

1. To what extent must use directions and other label language reflect data submitted? e.g.
    - undiluted product only tested yet use directions may suggest dilution of product.
    - use of stickers, adjuvants - data to support?
2. Timing, method of application etc.?
3. Rates of application.
   What data is required to support label rates; to support changing rates?
4. Guarantee/Potency T.ni bioassay?
   Data on target pest?
   Endotoxin concentration?
5. Possibility of developing "standardized"/uniform B.t. labels?
6. What data required to "add a pest" to label?
7. Stability of formulations:
    a. Storage Stability - define physical and biological properties which must be measured; how long; what temperatures.
    b. Stability of diluted tank mixtures.
    c. Are current storage instructions on labels adequate?
    d. "Best before date".

SUMMARY OF QUEBEC CITY EFFICACY MEETING
- CONCLUSIONS AND RECOMMENDATIONS

LABORATORY/GREENHOUSE EVALUATION

Product potency
T.ni bioassays - as a standard measure of quality control/potency guarantee.

Dose/Mortality Relationship
Lab bioassay of formulation which measures dose/mortality relationship (including regression analysis) against major target pests should be required (diet or comparable bioassay).

Foliar Persistence
Not required for regulation purposes but any claims made must be backed with supporting data.

Physical Properties (viscosity and specific gravity still required)
No further properties required at this time for regulation.

Strain Identification
Identification at the level of the toxin genes should be required for identification purposes only.

Action: Jean and Kees will write preliminary outline.

DEVELOPMENT OF UNIFORM PROTOCOLS (see verbatim proceedings)

Use of Replicates
Any field trial has to include measurements in all major parameters which impact efficacy. The fewer parameter measurements, the more replicates required.

Protocol Development

Action: Committee of people set up to develop a basic set of protocols (must have some flexibility) - same committee will also review efficacy.

List of Parameters for Committee to Consider
(Minimum parameters to be included in any field test)

- prespray and postspray counts.
- intermediate counts.
- sampling - number of trees dependent on species.

- defoliation measure.
- development of insects.
- development of trees.
- amount of damage on trees prior to test.
- weather parameters
  - at time of application
  - postspray
- inclusion of positive control for reference point.
- minimum size requirement for block size - dependent on type of application.
- assay of test formulation and reference product for potency verification prior to spray.
- data analysis.

Documentation Parameters

- dose response relationships.
- topography.
- application specifications and description of application equipment.

DOCUMENTATION/REPORTING OF DATA (see verbatim proceedings)

Basic Format

Should have consistent format with basic minimum data. Don't need to set up GLP; this should fall out of protocols when determined.

Preliminary Reports

Considered to be a slow process and not very useful. Final reports should be pared down; raw data not required in appendices but must be provided if requested. Additional pertinent information re: product performance may be included in appendices.

Action - Kees and Ed to develop basic format for documentation/reporting of data.

LABELLING

Dilution of Product (at time of application)

Supporting data not obligatory but with the caveat that information should be supplied for mixing if problems can arise at different dilution ratios.

Stickers

Older labels should be updated to remove obsolete sticker information. New labels must have supporting data if stickers are recommended in use directions.

Label Rates

Recommended dose rates (B.I.U.s/ha) should be based on efficacy data.

Registration of Different Formulations
Minor formulation changes may require less than three trials. Major formulation changes require three acceptable trials for registration. Agriculture Canada will decide if formulation changes are major or minor.

Acceptability of U.S. Data
U.S. data are acceptable if results are from similar geographic or climatic conditions. Other conditions being equal, testing need not be repeated in a number of provinces.

Time Period Required for Trials
One year testing may be adequate. Three successful trials should be done in different locations. One or more operators may be used.

Minimum Requirements for Minor Pests
Formulation must have satisfied requirements for a major pest. Issuance of temporary registration may be possible based on appropriate lab tests or small plot testing. Results of operational use required to support full registration. Recognition that regulatory requirements must be flexible.

*Definition of Efficacy**
Attempts to define efficacy interesting but inconclusive (see verbatim proceedings).

* (see the last word on definition of efficacy - J. Churcher, N. Carter ... in a format suitable for framing)

CONCLUSION

Efficacy Advisory Committe

1. Ed Kettela - confirmed
2. Kees VanFrankenhuyzen - confirmed
3. Leo Cadogan - nominated in absentia
4. Pierre Therien - confirmed
5. Chandra Nigam - confirmed
6. ? - to be decided
7. "Pest - specific experts" as required

Action Plan

1. Consideration of additional committee members.

2. Streamline reporting requirements, Ed and Kees - Jan. 1991.

3. This year's field data will be assessed by committee.

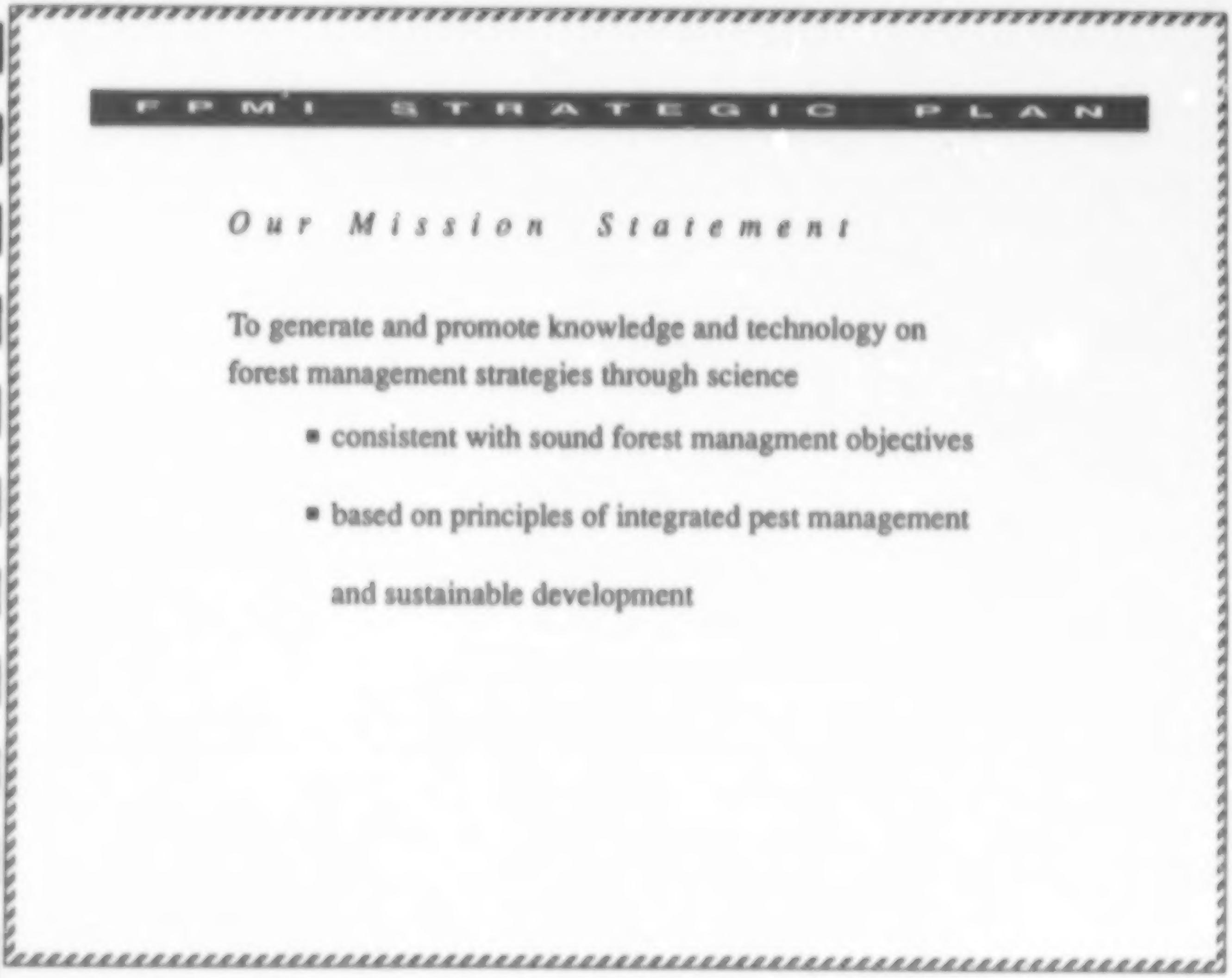
4. Committee will prepare draft protocols. (initial emphasis on "major" pests)

   - draft of basic protocol by Feb. 1991

5. It was agreed that researchers/cooperators will have to submit protocols for review by efficacy committee by March 1 of testing year.

IV. Research, Monitoring and Other Reports/ Recherche, surveillance et autres rapports

FPMI Strategic Plan **Initiative**
presented by E. Kondo, FPMI



FPMI STRATEGIC PLAN

Our Mission Statement

To generate and promote knowledge and technology on forest management strategies through science

- consistent with sound forest managment objectives
- based on principles of integrated pest management and sustainable development

FPMI STRATEGIC PLAN

Major Program Thrusts

1) Development of next generation control strategies

- Full integration of forest pest management tactics and strategies guided by the principle of sustainable development
- In collaboration with the Petawawa National Forest Institute -developing integrated forest management decision/support systems

2) Providing the forestry focus for pesticide evaluation, registration, and advice to Federal and Provincial regulatory agencies with regard to operational efficiency and environmental impact

Major Program Thrusts (cont'd)

3) Development of next generation pest control products
    - Biological control research and development with microorganisms, pheromones, growth regulators, and other natural products and genetic manipulation of insect pathogens
    - Evaluation of efficacy and environmental impact
4) Pesticide application technology including advice to clients
5) Development of integrated vegetation management strategies in consultation with regional establishments and clients

FPMI Client Base

- Scientific Community (Universities, Research Institutes, Associations, etc.)
- Nationally
- Internationally
- Pesticide Regulators
- Federal (includes Env. and Health Agencies)
- Provincial (includes Env. and Health Agencies)
- Forest Pest Managers (National and International)
- Provincial
- Industry
- Municipal
- Private
- Pesticide Industry
- Regional ForCan Establishments
- Decision Makers
- ForCan Headquarters
- Politicians
- Other renewable, natural resource agencies
- Public and public interest groups (e.g. NGO's)
- Environmental agencies and groups (in other than a regulatory function)

Implementing Guidelines

- Highly efficient management and coordination of FPMI resources.
- Close coordination and partnership with other stakeholders.
- Continued active use of advisory bodies (including CORE, Scientific Working Groups, FPMI and National Research Advisory Committees) to provide guidance on S & T directions and priorities.
- Closer involvement with regional development agreements within the research component where appropriate.
- Working with the Science Directorate of ForCan to actively support and participate in "forestry S & T by industry and provinces; this will include use of such mechanisms as formal joint projects, networks, scientist fellowships and awards, exchange programs, and external grants and contracts, which conform to the government's Science and Technology Centres policies".
- Support and work with the Science Directorate in the expanded use of MOU's with other agencies and organizations, both nationally and internationally, to ensure the most effective use of total available resources.
- Staff development and enrichment
- Research Networking

SUMMARY OF FPMI AND FOREST SECTOR MAJOR INITIATIVES

Errol Caldwell

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Staff Changes

A number of staff changes have taken place at FPMI since the last Pest Control Forum. In April Dr. George Green retired as Director General of the Institute and Dr. Ed Kondo was appointed as our new D.G. Dr. Kondo's former position as Director of the Biorational Control Agents Program will be filled permanently on 1 April 1991 when we are joined by Dr. Bill Cheliak who is currently the biotechnology coordinator within the Science Directorate at Forestry Canada headquarters. Dr. David Tyrrell, research scientist for the Fungal Pathogens project will be acting Program Director for the Program until 1 April and after that he will assume the duties of a new Program Director's position at FPMI in Planning and Research Support. Dr. Tyrrell will also continue his scientific responsibilities as Project Leader for the Fungal Pathogens Project.

Mr. Craig Howard currently with the Ontario Ministry of Natural Resources will be joining FPMI staff effective 7 January 1991 as our Project Leader for Pesticide Regulatory Affairs. This is a new position that will be responsible for coordinating FPMI and Forestry Canada's role as forest science advisor to the federal pesticide registration process. Craig will thus be assuming most of the regulatory advisor responsibilities that are currently being addressed by myself as Program Director. Craig will also assist in our application technology research and technology transfer activities. FPMI will strengthen its Application Technology Program even further by establishing a new project in Technology Development. Our pilot Mr. Art Robinson and our equipment design technician Mr. Jim Beveridge will be co-leaders of this new project.

Several other personnel shifts have occurred at FPMI which involve re-assignment of Bert Zylstra from Leo Cadogan's Insecticide Field Efficacy Project to Peter DeGroot's Study in our Plantation Pest Management Project. Bert's former position will be filled in the near future. Finally, Andrij Obarymskij has been seconded to Dr. Phil Reynold's Vegetation Management Project from Plantation Pest Management.

Research Highlights

Changes in research focus are taking place at FPMI in response to departmental and FPMI strategic plans. The key areas identified in FPMI's Strategic Plan were described earlier in Dr. Kondo's presentation. Some of these key initiatives will become apparent during some of FPMI's presentations or are included in separate staff Forum reports. The following is a very brief summary of key directions:

FP-10 Bacterial Pathogens

Coordination of the Biocide Network continues. In particular, research on B.t. toxins, their mode of action and improved characteristics through genetic research and manipulation. Modified operational use patterns are being investigated to maximize B.t. efficacy while minimizing effects on spruce budworm parasites.

FP-11 Fungal Pathogens

As mentioned previously, David Tyrrell research scientist for this project has joined management ranks at FPMI. He will however continue his role as project leader for Fungal Pathogens which is considered to be an important component of FPMI's biotechnology and IPM strategic directions. FPMI expects to return this project to a fully operational level if not expand on its mandate in future through possible Green Plan or other resource opportunities. If opportunities permit, FPMI will also seek to expand its program into areas of plant pathology and wood preservation research.

FP-13 Viral Pathogens

The establishment of the Microbionet research network has resulted in increased resources for genetic improvements to insect viruses that will have significant potential for forest insect control. The development of such alternative, "Next Generation" pest control products is a key element of FPMI's strategic direction. Field efforts continue with Gypsy moth NPV in order to refine formulation and application parameters. A formal request for registration was submitted to Agriculture Canada this year.

FP-20 Insect Pathogens in Vitro

Cell culture research and technology has become a key area as we move closer to developing mass production capability for next generation or microbial pesticides.

FP-22 Immunochemistry

Immunochemistry is an important tool in identifying and understanding the behaviour of next generation microbial pest control products. Thus this project is expected to continue to play a large role in biotechnology oriented research efforts.

FP-23 Biological Systems Analysis

The development of a systems approach with other establishments such as the Petawawa National Forest Institute is essential to the successful implementation of our IPM systems strategy. Modelling will play a major part of this effort and will be the focus of this project.

FP-30 Pheromones

Pheromone research is expected to play a major role in any IPM based control strategy. Pheromones may also become more than a monitoring tool for insect pests as we seek out new alternatives for environmentally conscious pest control methods.

FP-31 Insect Growth Regulators

IGR's and other insect hormones and their derivatives are expected to play an important role as possible alternatives to broader spectrum, neurotoxic insecticides. Research by Blair Helson and Art Retnakaran have demonstrated significant potential for RH5992 as a possible alternative for spruce budworm and other insect pests such as white pine weevil. Discussions are currently underway with the manufacturer Rohm and Haas to plan a research program designed to address registration needs.

FP-50 Insecticide Toxicology

The focus of this project has shifted and will give priority attention to natural and naturally derived products with potential for insect control. In particular we intend to take the lead role in testing the potential of promising new materials such as Alpha-T, MK243, abamectin, the aforementioned RH5992 and others for the control of a range of forest insect pests. This is also a key area of attention identified within our strategic direction.

FP-51 Insecticide Field Efficacy

This project has become less involved in the routine field testing of standard, modified B.t. products and will instead concentrate more on providing the pest biology and efficacy component of our application technology and alternative technology research efforts.

FP-52 Plantation Pest Management

The development of an Integrated Pest Management Systems approach for seed orchards will be given priority within this project and a workshop in this regard is being planned to be held at FPMI in March as part of our larger role in developing a coordinated IPM program capability within Forestry Canada.

FP-53 and 54 Vegetation Management

Improvements in application technology will continue to be a high priority. In addition, FPMI is looking to expand its efforts in vegetation management by including alternative vegetation management strategies in addition to herbicides in its research program. This is a component of an integrated vegetation management approach which will become the cornerstone of our future efforts. This will involve cooperation with others involved in vegetation management research such as the Pacific and Yukon Region with whom we plan to collaborate in possible development of mycoherbicides. In the next year FPMI will be developing a problem analysis and an action plan to define our strategic directions in vegetation management research and development.

FP-61 Pesticide Formulations

Improved pesticide formulations for microbial insecticides and for herbicides has been the primary focus of this project. Improved handling characteristics, deposition and adhesion are key areas that will continue to be investigated.

FP-62 Spray Cloud Behaviour

This project will continue to play a lead role in the research and development of scientific data and establishment of appropriate guidelines concerning pesticide drift and buffer zones. Improved pesticide application systems and parameters will also be addressed as FPMI significantly increases its role in collaborative application technology research and development.

FP-70 Environmental Impact

As part of our efforts at developing next generation and in particular, microbial insecticides, this project is developing new methodologies and protocols for the environmental assessment of new control technologies. Our environmental efforts in other areas including our more traditional leadership role in pesticide impact investigation, will continue and expand in response to public concern over forestry environmental issues and practices. Many of our efforts will be resourced from Green Plan initiatives.

FP-71 and 72 Pesticide Environmental Fate

New methodologies and technology will be developed as we expand into next generation pest control products. In particular immunoassay and other techniques for determining residues and fate of naturally occurring and genetically modified microbials will be developed or refined. These projects will also become involved in the discovery, identification and purification of natural products that have potential for use in integrated forest pest management programs.

In summary, FPMI key strategic areas of activity will include:

- development of IPM consistent pest control technologies and related decision support systems for forest pests including insects, diseases and competing vegetation.

- development of next generation microbial insecticides and herbicides.

- development of natural and naturally derived insecticides and herbicides.

- improved pesticide applications and related technology.

- enhanced scientific advisor role for the pesticide registration process.

Other Major Activities

FPMI has participated in activities related to the Pesticide Registration Review Team either directly as a federal advisor to the process or via the Forest Pest Management Caucus. A comprehensive brief was prepared and forwarded to the Review Team for their consideration. This brief was also adopted by the FPMC in their submission to the Team. A copy of this brief is available from FPMI or from CPPA, the secretariat for the FPMC.

FPMI has played a major role in helping to develop an IPM program within Forestry Canada's Green Plan initiatives. Some background material used in support of this IPM proposal is attached to this report for your information.

In relation to Forestry Canada's Strategic Plan, FPMI has developed an Action Plan for pursuing strategy no. 16 of the plan which states that Forestry Canada will "develop and encourage the use of effective, environmentally acceptable and economically viable pest and disease control products and management strategies". The main focus of this Action Plan is IPM.

As part of its role within the FPMC, FPMI has taken the coordinating role for the development of economic benefit assessments for forest protection activities and pest control products. Contracts currently underway include benefit assessments for spruce budworm pesticides including fenitrothion, B.t. and aminocarb as well as vegetation control products triclopyr and hexazinone. These benefit assessments as well as others currently under development, will be used as case studies for a comprehensive general assessment of the economic benefits associated with forest protection operations. Some of these case studies are expected to be completed by the end of the year and the overall document by next summer.

Finally, FPMI continues to be involved with other registration advisors in the fenitrothion special review being undertaken through the Pesticides Directorate of Agriculture Canada.

INTEGRATED FOREST PEST MANAGEMENT

Background

Sustainable development of Canada's forest resource is the key to its environmental and economic stability. Sustainable development is a cornerstone of Forestry Canada's Strategic Plan and the direction that the department will take in its research and development activities. In developing improved management systems for this valuable, renewable resource, it is imperative that we foster integrated resource management to sustain its ecological diversity, productivity and renewal capacity. Multiple use values such as the forest industry, fish and wildlife, air and water quality and species diversity must be harmonized to maintain this resource for the well-being of present and future generations of Canadians.

Protection of our forest resource against damaging insects, diseases, competing vegetation and other pests is essential to sustainable development. Losses from forest pests is estimated at two-thirds of the total annual harvest. These losses also impact on non-consumptive, public use of the forest resource. Methods used in the management of pests must be consistent with Federal government and public desires to preserve the ecological integrity of our diverse forest resource. Thus,

Forestry Canada, through research and development programs will give priority to development of Integrated Forest Pest Management practices to encourage environmentally acceptable, and economically viable pest management strategies.

Integrated forest pest management (IFPM) is a key component of integrated forest management. Its principles can be used to manage pest populations of destructive insects, tree diseases and competing vegetation. IFPM provides an ecological approach to reducing pest damage to economically acceptable levels through knowledgable, integrated use of a variety of pest management options including: predators, parasites, pathogens, pest biology, population dynamics, genetically resistant tree species, silvicultural practices, natural control agents and, as a last resort, appropriate use of synthetic pesticides. Although IFPM is not a new concept, development of IFPM tools will be a key component of Forestry Canada's research priorities in the 5 year mandate of the departments' Green Plan initiatives.

Deliverables

A priority of Forestry Canada research is the development of innovative pest management techniques essential for successful IFPM. Associated with the development of these methods is the overriding emphasis on preserving environmental integrity. A major focus of all pest management research will be parallel environmental impact studies to delineate the effects of such strategies on the forest ecosystem. Innovative pest management research activities fall within the following areas:

Biotechnology Thrusts

The application of Biotechnology to the control of pest organisms is currently at a critical pioneering stage. In some cases operational use will take some time to develop.

The use of microorganisms to help manage insect, disease and vegetation problems is an approach for forest protection that is consistent with the environmental objectives of Canadians. As with all IFPM approaches, the use of microbial pathogens in the management of pest populations is not designed to eliminate the population but to keep it within normal endemic (not epidemic) levels. Forestry Canada research has resulted in development and use of Bacillus thuringiensis (B.t.) and several insect specific viruses in forest protection programs. The development of such "next generation" pesticides can be enhanced significantly through biotechnical methods and genetic engineering. Given adequate resources, the following goals are achievable within the 5 year time frame of the Green Plan:

- development of genetically improved insect specific viruses for pests such as the spruce budworm.

- development of formulations for the efficient application of microbial pest management tools.

- development of a pilot plant in cooperation with private industry, for commercial production of microbial insecticides.

- development of improved strains and formulations of Bacillus thuringiensis (B.t) for managing selected lepidoptera.

- development of methods and criteria for assessing the environmental impact and behaviour of "next generation" pesticides.

- development of plant pathogens, particularly fungi, as potential mycoherbicides for the management of competing vegetation.

- identification of microorganisms to inhibit and manage the incidence of forest diseases.

- identification of the potential for developing genetically enhanced tree species to significantly increase crop resistance to damaging insects, diseases or plant competition.

- identification and modification of microbial processes for the enhanced degradation of pesticide residues.

Natural Pest Controls

Forestry Canada has made significant contributions to national and international research on parasites and predators of forest insect pests resulting in excellent control of a number of species. Success has also been achieved in the management of plant pathogenic organisms. There is need for enhancement of such research efforts as well as research into development of other natural pest management mechanisms. Priority will be given to:

-identification and synthesis of naturally derived insect, microbial and plant products with potential in the management of forest pests.

- increased efforts in the identification, rearing, development and dissemination of insect parasites, including nematodes, as pest management tools.

Silvicultural Controls

The techniques used to harvest and manage our forests can have a profound influence on the incidence, impact and management of pest populations. Better understanding of these principles can lead to silvicultural practices which help maintain pest populations at endemic levels. Research efforts will be increased for the:

- identification and development of silvicultural means to manage pest insects, diseases and competing vegetation.

Improved Pest Management Field Operations

Forestry Canada emphasis is placed on developing alternatives to broad spectrum chemical pesticides. However, until these alternatives are registered and in operational use, it is essential that the quantity of chemical products used is kept to a minimum. One method of achieving this goal is through the development of efficient and target oriented application methods. Research in this area will focus on:

-reducing quantities and dosage rates of pesticides through improved application systems and techniques.

- improved targeting of pesticide applications through improved guidance systems and identification of adequate buffer zones for the protection of sensitive, non-target habitats.

Developing an IFPM Capability

Development of pest management strategies and expertise in the above areas is essential to formulating IFPM systems and operational procedures. There must be a professional capability to integrate these strategies utilizing a systems approach that is operationally feasible.

A pre-requisite to the integrated management of any pest is a thorough knowledge of pest biology, pest population and forest stand dynamics, damage thresholds and damage prediction systems. Given sufficient resources:

- Forestry Canada will establish a team of integrated forest pest management specialists to work with forestry scientists and forest sector clients to assist in the development and operational acceptance of IFPM approaches.

- Forestry Canada will develop a system for IFPM using a relatively simple example. The development of such a system for the integrated control of cone and seed insects and diseases in forestry seed orchards will become a prototype for other management models which will be developed in the longer term.

- Forestry Canada will strengthen Forest Insect and Disease and other national and regional capabilities to expand the knowledge base necessary for developing decision support systems for the integrated management of forest insects, diseases and competing vegetation.

Linkages

The successful development and operational acceptability of IFPM strategies depends on a very strong link with a number of collaborators and clients. Procurement of adequate resources and appropriate scientific expertise will be dependent on establishing a number of research networks and leveraging of research funds. Such networks and cooperative relationships will be given priority in the allocation of funds for the above activities. Several networks have already been established eg. Biocide (to facilitate improvements in B.t. technology) and Microbionet (to facilitate development of microbial based insecticides through biotechnology).

Establishment of a comprehensive communications and technology transfer strategy is an essential component of future Forestry Canada thrusts in developing pest management applications. This is important for gaining both client and public acceptance and credibility in the programs to be implemented.

- Forestry Canada will take the lead role in establishing appropriate networks to facilitate development of ecologically sound forest insect, pathogen and vegetation management strategies consistent with the principles of IFPM.

- Forestry Canada will strengthen its role as a regulatory advisor with Agriculture Canada, Environment Canada, Health and Welfare and Fisheries and Oceans and will work directly with these departments, forest industry, pesticide manufacturers and other forest sector clients in developing acceptable pest control technologies.

- Forestry Canada will develop a comprehensive communications and technology transfer strategy to assist in the successful implementation of integrated pest management strategies.

RESEARCH STUDIES ON PHYSICOCHEMICAL ASPECTS OF PESTICIDE PERFORMANCE (CONDUCTED IN 1990)

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Introduction

During 1990, the Pesticide Formulations Project at FPMI undertook two field studies and two laboratory studies to examine (A) rainfastness of foliar deposits of B.t. and glyphosate formulations under field conditions; and (B) influence of adjuvants on rainfastness of glyphosate; and role of physical properties of end-use mixtures of B.t. on droplet size spectra of the spray cloud, droplet spreading on foliage, and deposits on glass plates, under laboratory conditions.

A. Field Studies:

1. Effect of Droplet Size and Cumulative Rainfall on Rainfastness of Foray 48B Deposits on Balsam Fir Foliage under Field Conditions:

A small scale field study was conducted using the single tree treatment technique to determine rainfastness of foliar deposits of B.t. as determined by spruce budworm bioassay using 4th instar larvae. Foray 48B was diluted with water and sprayed over balsam fir seedlings (about 1 m high) at a rate of 32 BIU in 4 L/ha, using a spinning disc atomizer, Micron Flak^R, calibrated to provide a narrow drop size range with a number median diameter (NMD) of 80 µm and a volume median diameter (VMD) of 86 µm. Drops were counted on fully flushed needles and drops/cm^2 were evaluated.

Simulated rainfall of two drop size spectra (almost monosized drops), with VMD values of 250 and 400 µm, and cumulative rainfall of 1 and 3 mm, were generated using Micron Herbi^R, and applied onto the seedlings at 24 h after B.t. application. Foliar branch tips containing fully flushed young buds were collected at different intervals of time up to 14 d after B.t. treatment, for bioassay using laboratory reared spruce budworm larvae. Mortality was assessed daily, and body weight depression once in two days, for a period of 14 d after treatment.

A comparative evaluation of the data on post-spray (within 15 min after application) and pre-rain samples (i.e., those collected at 24 h post-treatment) indicated that about 30% of B.t. activity was lost in 24 h after application. B.t. deposits were washed off under both intensities of rainfall, but wash-off was significantly higher at 3 mm than at 1 mm rain. Cumulative rainfall influenced B.t. wash-off from fir foliage much more than the droplet size of rain. Body weights were more depressed and mortality was higher in insects fed with buds collected before the rainfall, than with those collected post-rain. The data will be used to develop a model to understand the inter-relationships between size and impact velocity of rain drops, cumulative rainfall, and B.t. wash-off from balsam fir foliage.

Body weight depression and bioassay results on samples collected up to 14 d after treatment from seedlings that received no rain indicated that initial loss of *B.t.* activity was rapid within within two days after treatment (a loss of about 50% of the deposited amount) but further loss was relatively slow. Measurable but low *B.t.* activity still persisted for up to 9 to 10 d after treatment. This was detectable both by body weight depression and larval mortality. Further studies are under way to understand the mechanism of loss of *B.t.* activity from treated foliage.

2. Glyphosate Wash-off from Trembling Aspen Foliage under Simulated Rainfall after Application of End-use Mixes of Vision^R with and without Silvet^R L-77 Adjuvant - A Field Study:

A small scale field study was conducted using the single tree treatment technique to investigate glyphosate wash-off from trembling aspen seedlings, as determined by a colorimetric method to quantify glyphosate concentration in the washings, and by quantification of chlorophyll depletion in the treated leaves. The commercial formulation, Vision^R, was diluted with water to provide a dosage rate of 0.5 kg of glyphosate (acid equivalent) in 15 L/ha. This was sprayed over trembling aspen seedlings (about 1 m high) without and with the rainfastening adjuvant, Silvet L-77, (at a concentration level of 0.5% v/v of the adjuvant), using a Micron Herbi^R spinning disc atomizer, calibrated to deliver nearly monosized droplets with a VMD of 250 µm. Spray droplets were collected in beakers of castor oil and sized while the droplets were sedimenting towards the bottom of the beaker.

At 12 and 24 h after glyphosate treatment, simulated rain was generated using a hydraulic nozzle to deliver a drop size range of 115 - 1800 µm in diameter (with a VMD of 1250 µm) and was applied over the seedlings to provide a cumulative rain of 1 and 5 mm (with rainfall intensities of 5 and 10 mm/h respectively). All the rainwashings were collected in large aluminum pans lined with plastic sheets. Rain drop sizes were also assessed by collecting them in castor oil, followed by microscopic examination. At two weeks after glyphosate treatment, foliage samples were collected for assessing chlorophyll depletion.

In the laboratory, the rainwashings are being analysed for glyphosate content using a colorimetric method. The foliage samples are being homogenized, extracted with acetone/water and the chlorophyll content is being determined by using another colorimetric method. The data will be used to understand the complex relationships among the various parameters, impact velocity of rain drops, glyphosate wash-off, chlorophyll depletion on treated leaves, and rainfree period after treatment.

B. Laboratory Studies:

1. Effect of Adjuvants on Glyphosate Wash-off from White Birch Foliage by Simulated Rainfall:

The effect of six surfactant adjuvants (Atlox^R 3409F, Triton^R X-114, Span^R 20, Ethokem^R, Ethomeen^R and Silvet^R L-77) on glyphosate wash-off from white birch (*Betula papyrifera* Marsh.) foliage was studied at 2 and 6 h after treatment with end-use mixtures of Vision^R at the rate of 1 kg of active material (acid equivalent) in 35 L/ha area of leaf surface. The investigation consisted of two parts. In part I, radiolabelled herbicide was used to determine the maximum amount washed off ('Worst Case Scenario') by rinsing treated foliage with water. At 2 h after treatment, 84% of the applied amount was washed off when no adjuvant was present, and at 6 h the washable amount decreased only to 72%. Out of the six adjuvants tested, Ethomeen (a cationic surfactant) and Silwet L-77 (an organosilicone surfactant) contributed to a significant increase in rain protection for glyphosate deposits on foliage. However, Silwet L-77 provided the least rain-washing at the two rain-free periods studied, since the amount washed off decreased to 51 and 42% at 2 and 6 h rain-free periods respectively. In Part II of the investigation, non-radiolabeled herbicide was used, and glyphosate washoff was assessed colorimetrically at 2 and 6 h after treatment using cumulative rain of 1 and 5 mm. Results are given below:

End-use mixture	Wash-off at 2 h (percent of applied)		Wash-off at 6 h (percent of applied)	
	1 mm	5 mm	1 mm	5 mm
Vision	68	77	61	70
Vision with Ethomeen	53	62	48	54
Vision with Silwet L-77	39	45	33	39

Cumulative rainfall played a greater role in glyphosate wash-off than rainfall intensity. Again Ethomeen and Silwet were the only two adjuvants which significantly reduced glyphosate wash-off at 2 h and 6 h rain-free periods, although Silwet lowered the amount washed off much more than Ethomeen. A rain-free period of more than 6 h might be needed when a rainfastening adjuvant is not added to the end-use mixtures of Vision. However, further investigations are currently being carried out to determine the effect of rainwashing on herbicidal activity of glyphosate on white birch seedlings.

2. Influence of Physical Properties of Foray 48B on Droplet Size Spectra, Deposits on Glass Plates, Droplet Spreading and Adhesion onto Balsam Fir Foliage:

Foray 48B was diluted with water to provide a dosage rate of 32 BIU in 4 L per ha. The undiluted and diluted formulations were sprayed in a laboratory spray chamber onto potted seedlings of balsam fir at two humidity conditions, of 90% and 70% respectively, using a Micron Flak^R spinning disc atomizer, calibrated to deliver a narrow size range with a VMD of 85 µm. Both formulations were sprayed using the same volume rate of 4 L per ha so that droplet size spectra and spreading can be compared. Droplets were collected in castor oil for size assessment. Droplet spreading was examined on fully flushed fir needles. Physical properties, such as viscosity, surface tension and volatility were determined for both the neat and diluted formulations.

The data indicated that droplet size spectra and degree of spreading are both influenced by a complex combination of the three physical properties of the formulations, although surface tension played a greater role on droplet spreading than the other two parameters. At 90 and 70% relative humidity values, no spherical droplets could be found on fir needles and on glass plates. About 98% of the droplets on the two surfaces were hemispherical and only about 2% underwent complete spreading. The data indicated that compared to some earlier water-based B.t. formulations that are registered for forestry use, Foray 48B provided improved spreading and adhesion onto fir needles, since no spherical droplets were formed at the two relative humidity conditions. Further research is on the way to develop a model for droplet spreading on surfaces so that the role of physical properties can be better understood.

INSECT GROWTH REGULATOR UPDATE FOR 1990

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Insect growth regulators (IGRs) belong to a new generation of pesticide called biorationals. Various classes of these compounds are being developed to control insects by interfering with their growth and development. **Chitin inhibitors** alter the normal development of cuticle and hence the molting process itself. **Juvenile hormone analogs** interfere with the normal growth of insect larvae and eventually prevent pupation. The most recent class of IGRs is the **ecdysonoid**. These compounds mimic the molting hormone ecdysone and are responsible for stimulating precocious molting in exposed larvae. All of these new classes of compounds are being tested in both the laboratory, under controlled conditions, and in the field.

The 1990 field season was reserved for the testing of Dimilin, a chitin inhibitor, against the white pine weevil and for initial probes of the ecdysonoid, RH-5992, against the spruce budworm.

In the laboratory, work is continuing on attempts to isolate and use a microsporidian plasmid as a vector to insert deleterious genes for insect control.

WHITE PINE WEEVIL STUDIES

Field studies using Dimilin against the white pine weevil were carried out in three different locations including Sault Ste. Marie. In Quebec, a research plot has been established for conducting an intensive five year study of the habits of white pine weevil and of the potential of Dimilin as a control agent for this insect. Back-pack sprayers were used to spray trees individually, in one part of the plot, and to cover larger blocks in another part of the area. Both approaches produced positive results, however, the data was distorted slightly due to a period of unseasonally warm weather and early insect activity in the test area, which unfortunately resulted in delayed spraying. Experimental success with IGRs depends on delivering the material to the target insect prior to mating. The early spring put us about one week behind schedule and some mating occurred before the IGR was applied. Instead of 100% damage control, we noticed as much as 11% of the leaders to be weeviled.

In Maine field studies were carried out using both ground spraying and aerial approaches. These trials are being spearheaded by Dr. John Diamond with the cooperation of Uniroyal, the North American distributor of Dimilin. All ground spray applications conducted by Dr. Diamond over the years using Dimilin have provided almost 100% damage control when applied before the onset of mating activity as per our instructions. To date, the aerial spraying has not proven effective. In defense of these aerial attempts, none of them have been started until the insect was well into its mating season. This is a problem that keeps recurring when trying to employ contract help. In an effort to rectify this problem, we are presently tryiny to make arrangements to have our own spray plane available for the 1991 spray attempt in Maine.

In Sault Ste. Marie, ground spray trials were conduced to coincide with the work being done in Quebec. Similar spray equipment was used to deliver a dose of Dimilin to the leader of the test tree. As in Quebec, an early spring warm spell induced mating activity prior to the spray taking place. Like Quebec, we were about one week behind schedule and our results mirrored theirs with about 11% of the trees receiving weevil damage to the leaders.

SPRUCE BUDWORM TRIALS

Earlier trials with molt inhibitors were largely unsuccessful against the spruce budworm. Recently, our laboratory assessment of a new ecdysonoid, RH-5992, indicated that the spruce budworm was extremely sensitive to low doses of this material. In 1990, small ground spray trials were conducted in the Gaspé peninsula using this new material. The experimental plots were located at a high elevation and exposed to extremes of dehydration and cold. The insect population initially was plentiful and robust, but, the rigors of that location took its toll. The results of the work indicated high incidence of precocious molting with total control and very little defoliation. The controls showed some defoliation but the results could be improved next year.

LABORATORY INVESTIGATIONS

Today, environmental concerns are pushing research in new and interesting directions. New approaches to insect control are employing the techniques and technology of molecular biology. We are in the process of isolating the microsporidian parasite, Nosema disstria, from the MD66 cell line of the forest tent caterpillar (Malacasoma disstria). From microsporidia we hope to isolate a plasmid into which we can splice a gene such as the *B.t.* gene or a neurohormone gene. The new plasmid would hopefully possess the toxic capacity of *B.t.* or produce large amounts of the hormone and when inserted back into the microsporidia would make the transgenic microsporidian an effective control agent.

WHITE PINE WEEVIL CONTROL RESEARCH TRIALS IN ONTARIO

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White pine weevil, *Pissodes strobi* (Peck), has become a serious pest in many jack pine and black spruce plantations in Ontario and elsewhere. Jack pine and black spruce are two of the most important tree species in the tree improvement and reforestation programs in Canada. Spring applications of methoxychlor and leader clipping have been used, with varying success, to control damage by the weevil. In some plantations leader clipping is neither practical nor feasible, and in some high value stands, such as seed orchards or family tests, leader clipping is not desirable. Variable results with methoxychlor applications have usually been attributed, *post hoc*, to poor spray coverage, lack of persistence, or late timing, but scientific studies to investigate the performance of methoxychlor are few. Laboratory studies with the pyrethroid insecticide permethrin also indicated that it had good potential to control this pest. Therefore, the purpose of our study was to develop an effective control method for the control of white pine weevil in seed orchards and other high value stands where little or no leader loss is wanted. Reported here are the preliminary analyses of the bioassay and damage appraisal data from spray trials with methoxychlor and permethrin.

A jack pine plantation near Garden Lake, north of Sault Ste. Marie, Ontario was selected and divided into three blocks. Within each block, 16 50-tree plots were established. Four treatments, permethrin at 70 g and 140 g AI/ha, methoxychlor at 1 kg/ha, and an unsprayed control, were randomly assigned to four plots in each block. Calibrated Solo back pack sprayers, equipped with flat fan spray nozzles and pressure regulators, were used to apply the insecticides to the leader of each tree. The insecticides were applied on 4 May 1990, about 6-7 days after most of the snow had melted away from the base of the trees and 2-3 days after the snow melted from the site. The incidence of oviposition up to 4 May and consequent damage was determined by placing fiberglass window screen cages over the leaders of 35 untreated trees in each block on treatment day and examining these for damage in October. An additional 30 trees were sprayed with each insecticide on 4 May for bioassays. At weekly intervals, laboratory-maintained weevils were caged on three randomly chosen trees per treatment, to bioassay the residual effectiveness of the insecticide treatments. From 17 May to 4 July, four plots for each treatment were visited at biweekly intervals to monitor the incidence of leader damage. Beginning 12 July all 2400 trees were examined biweekly for leader damage; a final assessment was made on 17 September.

Weevil survival on the leaders treated with insecticides in the bioassay experiment was generally less than 5% for 6 weeks after treatment compared to 96% in the untreated controls. Thereafter, survival increased, probably due in part to the presence of new shoots which had not been treated. Weevil survival, between 7 to 10 weeks post-spray, was lowest in the methoxychlor treatment, followed by the 140 g and 70 g AI/ha treatments with permethrin. Oviposition was much lower on insecticide-treated leaders than the untreated control leaders. For example, a total of 440 eggs were laid on the control leaders during the 10-week bioassay period, while only 7 eggs were laid in the 70 g AI/ha permethrin treatment between the 7th and 10th week of the bioassay.

The results of the final assessment of leader damage in the treatment blocks are shown in Table 1. Clearly all three insecticides provided good leader protection. No significant difference in the level of leader protection (P=0.05) was found between the three insecticide treatments, but all insecticide treatments had significantly lower damage levels than the untreated control (Kruskal-Wallis, one-way ANOVA, with multiple comparisons, BMDP software package).

These preliminary analyses suggest that permethrin and methoxychlor can give good levels of weevil control when applied early by ground spray equipment. Additional studies to assess timing and persistence are planned for 1991.

Table 1. Leaders destroyed by white pine weevil 20 weeks after treatment with permethrin and methoxychlor, Garden Lake, Ontario, 1990

Treatment (g AI/ha)	Percent destroyed leaders, x ± SE Treatment Block 1	2	3	Pooled
Permethrin (70)	3.5 ± 1.0	1.5 ± 1.0	1.0 ± 0.6	2.0 ± 0.6
Permethrin (140)	1.0 ± 0.6	5.0 ± 0.6	7.0 ± 1.9	4.3 ± 1.0
Methoxychlor (1000)	1.5 ± 0.5	2.0 ± 0.8	2.5 ± 0.5	2.0 ± 0.3
Untreated control	13.5 ± 4.6	15.5 ± 3.7	16.5 ± 1.7	15.2 ± 1.9

RESEARCH ON THE TOXICITY OF INSECTICIDES TO FOREST INSECT PESTS IN 1990

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New Insecticide Development

We have been assessing the potential of 4 new insecticides for the control of forest pests: alpha-terthienyl, RH5992, abamectin and its semi-synthetic derivative, MK-243 in the laboratory. Alpha-terthienyl, a natural phototoxic compound from members of the plant family, Asteraceae, has been tested on several lepidopteran defoliators, sawflies, beetles and weevils previously in collaboration with Dr. J.T. Arnason, U. of Ottawa, Dr. W.J. Kaupp, FPMI, and A. Ceccarelli. In 1990 it was evaluated on gypsy moth larvae but further tests are needed to define its toxicity. Experiments on the effects of near-UV light exposure period on toxicity demonstrated that toxicity increases sharply with longer light exposures up to about 3 hours. Further increases up to 16 h. resulted in relatively small increases in toxicity. To date, all tests have been topical applications followed by exposure to near-UV light. We plan to assess its toxicity to spruce budworm and hemlock looper larvae by ingestion and crawling contact exposure.

RH5992 is a novel insect growth regulating compound discovered and under development by Rohm and Haas. Dr. A. Retnakaran, FPMI, and I have been evaluating this compound against several forest lepidopteran defoliators. I previously examined its toxicity to spruce budworm, eastern hemlock looper and gypsy moth larvae by direct contact and on sprayed foliage as well as its effects on feeding rates in comparison to standard chemical insecticides. RH5992 was very toxic to these pests and reduced feeding quite quickly. I am currently investigating the effects of exposure period to treated foliage on toxicity and the residual toxicity of RH5992 under natural weathering conditions. Abamectin has been isolated from a soil microorganism, Streptomyces avermitilis by the Merck Sharp and Dohme Research Laboratories and is now registered as a miticide in the USA. MK-243, a semi-synthetic derivative of abamectin, has recently been developed and is reported to have very high activity to Lepidoptera. We have just begun testing MK-243 on spruce budworm and hemlock looper larvae in comparison with abamectin. MK-243 appears to be extremely potent to these pests. It is more toxic than abamectin and around 1000X more active than fenitrothion. We plan to expand our screening program against several other forest pests, evaluate its effects on feeding rates and assess its residual toxicity.

Pine False Webworm

In 1990, D.B. Lyons, Forestry Canada, Ontario Region, and I collaborated in laboratory and field trials to develop an insecticide control strategy for the pine false webworm on red pine. Laboratory bioassays with 10 common, registered insecticides were carried out with newly hatched larvae on sprayed red pine branches. Carbaryl and permethrin were the most effective at low dosages. Field trials were then conducted with Ambush 500EC (permethrin) at 35, 70 and 2x35 gAI/ha, and Sevin XLR Plus (carbaryl) at 125, 250, 500 and 2x125 gAI/ha applied by mistblower in a red pine plantation. The double application of both insecticides and the 2 highest dosages of Sevin reduced larval numbers and defoliation.

Seedling Debarking Weevil

For the past three years we have been conducting insecticide bioassays with *Hylobius congener* adults in cooperation with Bruce Pendrel, Forestry Canada, Maritimes Region. The residual effectiveness of permethrin, chlorpyrifos and fenitrothion for protecting conifer seedlings for up to 2 years is being evaluated by spraying or dipping potted white spruce and red pine seedlings with selected concentrations of these insecticides, placing the seedlings outdoors and exposing weevils to them at yearly intervals. In 1990, two-year bioassays were conducted on red pine seedlings and one-year bioassays on spruce. Sprays of 1% permethrin and 2.5% chlorpyrifos provided the greatest protection.

Cone Beetles

We are screening insecticides against *Conophthorus* cone beetles in collaboration with P. deGroot. To date, fenitrothion, carbaryl, dimethoate, lindane, permethrin and azinphos-methyl have been tested on red pine cone beetle and white pine cone beetle adults by topical application. Both species were also exposed to branches dipped in permethrin.

Black-headed Budworm

We also conducted preliminary insecticide bioassays on black headed budworm, *Acleris variana* this year. Fourth-instar larvae appeared to be slightly more susceptible to contact sprays of MATACIL and fenitrothion than fifth-instar spruce budworm larvae.

White Pine Weevil

For several years we have been assessing the potential of pyrethroids, particularly permethrin, for the control of WPW adults in the laboratory with encouraging results. In 1990, P. deGroot, FPMI, and I collaborated in conducting a field trial to assess the effectiveness of permethrin in protecting leaders of jack pine from weevil attack. Further information on this trial is provided in a separate report.

USE OF LECONTVIRUS IN 1990.

A report to the 18th Annual Forest Pest Control Forum

(Ottawa, Ontario. 20-22 November 1990)

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Use of Lecontvirus in 1990.

J.C. Cunningham and W.J. Kaupp

Lecontvirus (nuclear polyhedrosis virus) for control of redheaded pine sawfly, *Neodiprion lecontei*, is the only registered viral insecticide which is used operationally in Canada on an annual basis. In 1990, Lecontvirus was supplied to Ontario Ministry of Natural Resources staff in 6 districts; 49 red pine and jack pine plantations, with a combined area of 677 ha, were treated (Table 1). Use in Espanola District includes 6 plantations (156 ha) treated by E.B. Eddy Forest Products staff.

Table 1. Lecontvirus applications in 1990.

District	No. of plantations treated	Total area (ha)
Bancroft	3	15
Blind River	5	40
Espanola	9	172
North Bay	5	97
Parry Sound	10	88
Tweed	17	265
Total	49	677

Some districts blanket sprayed entire plantations and others treated "hot spots" only to seed the virus into the sawfly population. It must be emphasized that this virus should be applied on early instar larvae. It is often applied too late, and a date beyond which it should not be used may be a better guideline than development of the sawflies. As the latest date for application, July 20th is suggested.

A request from Quebec Department of Energy and Resources for Lecontvirus came too late for its use in 1990, but material will be available for use in Quebec as well as in Ontario in 1991.

APPLICATION OF DISPARVIRUS AGAINST GYPSY MOTH IN ONTARIO IN 1990

A report to the 18th Annual Forest Pest Control Forum

(Ottawa, Ontario. 20-22 November 1990)

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Application of Disparvirus against gypsy moth in Ontario in 1990.

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Summary

Following successful Disparvirus trials in 1989 with a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) in an emitted volume of 5.0 L/ha, a reduced emitted volume of 2.5 L/ha was tested in 1990 using the same dosage as in 1989 and this was compared to 5.0 L/ha. The aqueous tank mix for both treatments contained 25% v/v molasses, 10% v/v Orzan LS, as a sunscreening agent, and 2% v/v Rhoplex B60A sticker. A Cessna Ag-truck fitted with 4 Micronair AU 4000 rotary atomizers was used for the 2 applications, 5 days apart, on mainly first instar larvae. Each treatment was applied on three plots about 10 ha in area and a further 3 plots were selected as checks. Pre-spray gypsy moth egg mass densities ranged from 2280 to 8900/ha in the 6 treated plots and from 2390 to 6690/ha in the 3 check plots.

In addition to defoliation estimates and egg mass counts, pupal counts in burlap traps and counts of male moths in pheromone traps were used in the assessment of the treatments. The criteria for a successful treatment on gypsy moth is defoliation of oak not exceeding 40% and post-spray egg mass densities below 1200/ha. In the 2.5 L/ha treatment, one plot had 46% defoliation, and two plots had post-spray egg mass densities above 1200/ha. Population reductions due to treatment (Abbott's formula) were 73, 82 and 90%. In the 5.0 L/ha treatment, defoliation ranged from 29 to 38% compared to 77 to 93% in the check plots. The plot with the highest pre-spray egg mass density of 8900/ha had a post-spray density of 1620/ha which was above the 1200/ha threshold; the other two were below the threshold. Population reductions due to treatment of 87, 91 and 95% were calculated for the 5.0 L/ha treatment. The 2.5 L/ha emitted volume was considered to be only marginally effective and 5.0 L/ha remains the recommended volume for application of Disparvirus using an aqueous tank mix.

Introduction

Aerial spray trials were conducted in Lindsay District in 1988 when a double application of Disparvirus using $1.25X10^{12}$ PIB/ha (total $2.5X10^{12}$ PIB/ha) in an emitted volume of 10.0 L/ha gave excellent control when applied on mainly first instar larvae. It requires about 1,000 gypsy moth larvae to produce this dosage and both the dosage and emitted volume were considered to be too high for operational use. In 1989, trials were again conducted in Lindsay District. The dosage was reduced to a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) and emitted volumes of 5.0 and 10.0 L/ha were tested. The aqueous tank mix contained 25% v/v molasses, 10% v/v Orzan LS and 2% v/v Rhoplex B60A sticker. Applied on first and second instar larvae, the 5.0 L/ha application was as good as the 10.0 L/ha and the lower dosage gave satisfactory results. Hence, the recommendation for Disparvirus application was revised accordingly.

An emitted volume of 5.0 L/ha is still higher than volumes used for Bacillus thuringiensis applications which are usually less than 2.0 L/ha. It was therefore decided to test Disparvirus in the aqueous tank mix at a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) in 2.5 L/ha and compare this to the same dosage in 5.0 L/ha.

Experimental plots and spray application

Six treatment plots, each about 10 ha in area, and three check plots were selected in an area of recent gypsy moth infestation in Simcoe District. Plots were all west of the town of Simcoe and within 25 km of the town. The same dosage was applied on all 6 plots. It was a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha). Two different emitted volumes, 5.0 L/ha and 2.5 L/ha, were tested. The tank mix contained 25% v/v molasses, 10% v/v Orzan LS, a lignosulphonate used as a UV protectant, and 2% v/v Rhoplex B60A sticker. The first spray application was on May 14th and the second, 5 days later, on May 19th. The FPMI Cessna Ag-truck fitted with 4 Micronair AU 4000 rotary atomizers was used for both applications. Meteorological conditions during the applications are given in Table 1. Gypsy moth larvae were mainly in the first instar and insect development on the two application dates is given in Table 2. Leaves were about 50% expanded on red oak and 25% expanded on white oak at the time of application.

Kromekote cards were placed at 15m intervals at right angles to flight lines in the plots where this was feasible. Results of the analysis of these cards are given in Table 3.

Table 1. Meteorological conditions during spray applications.

Date	Air temp at 10m (°C)	Ground temp at 1m (°C)	% RH	Wind km/h
May 14	2.8-7.8	2.3-8.3	93.5-91.8	1.0-2.6
May 19	6.4-7.4	6.0-7.9	81.0-79.0	1.0-3.0

Table 2. Larval development at time of applications.

Date	% L1	%L2	%L3
May 14	99.8	0.2	0
May 19	84.8	10.0	5.2

Table 3. Spray card deposit on Kromecote cards.

Plot	Emitted volume (L/ha)	Application number	NMD (μm)	VMD (μm)	Dmax (μm)	No. of droplets cm^2 (±SE)
1	5.0	1	42.2	124.9	444.1	21.0 ± 2.7
		2	31.8	91.4	308.4	12.1 ± 0.9
2	5.0	1	43.4	164.6	378.3	12.7 ± 2.6
		2	29.8	75.6	178.6	9.2 ± 2.1
3	5.0	1	51.5	236.0	378.3	12.1 ± 0.8
		2	34.1	57.0	211.0	3.6 ± 0.6
4	2.5	1	48.3	143.0	493.2	63.4 ± 7.4
		2	46.6	185.2	350.0	5.3 ± 0.8
5	2.5	1	37.3	153.1	425.2	35.4 ± 3.3
		2	41.2	147.6	250.0	3.1 ± 0.8
6	2.5	1	43.9	145.0	459.2	26.6 ± 2.8
		2	20.4	132.1	450.0	9.3 ± 0.8

Assessment

Egg mass counts were made on ten 10m^2 (0.01 ha) sub-plots in each treated and check plot using methods developed by Forest Insect and Disease Survey staff. Numbers were converted to egg masses per hectare. Counts were made in early May before hatching commenced and the same plots were re-examined in mid-October. Treated and check plots were paired on the basis of pre-spray egg mass densities and reduction in egg mass density was calculated using a modified Abbott's formula.

Pupal counts were made from burlap traps on three oak (red or white) trees in each of the ten 0.01 ha sub-plots used for egg mass counts in all treated and check plots. Strips of burlap 45 cm wide were folded double and nailed to the trunks of trees. The circumference of the trees was measured and pupal counts were converted to pupae/m of burlap. Pupal counts were made during the week of July 9-13.

Pheromone trapping was undertaken and 3 traps were placed in each treated and check plot on June 9-10. Lures were supplied by Dr. B. Leonhardt of the USDA Laboratory at Beltsville, Md; the concentration of pheromone was greatly reduced to avoid excessively high catches in green Multipher gypsy moth traps containing a dichlorovos strip to kill the male moths. Traps were hung 12.5m from the ground and 0.5m from a tree trunk. The traps were removed on Aug. 3 at the end of the flight period and the catch of male moths counted.

Defoliation estimates were made on 5 red oak or white oak 46-cm branch tips collected at mid-crown from trees in the ten 0.01 ha sub-plots used for egg mass counts. This was done at 8 weeks after the first spray application when larvae had ceased feeding and were either pupating or dead. A total of 50 branch tips was examined in each treated and each check plot. An estimate was made of the amount of foliage consumed on each branch and a mean was calculated for the plot.

Results

Pheromone trap counts of male moths are given in Table 4. Compared to check plots, the reduction in catches in the 2.5 L/ha treatment were 28, 36 and 46% and in the 5.0 L/ha treatment were 31, 42 and 78%.

Table 4. Moth catches in pheromone traps.

Plot no.	Emitted volume (L/ha)	Mean no.of moths/trap in treated plots (n=3)	Mean no. of moths/trap in corresponding check plots (n=3)	% catch reduction
1	2.5	559	1034	46
2	2.5	654	914	28
3	2.5	588	914	36
4	5.0	449	767	42
5	5.0	633	914	31
6	5.0	204	914	78

Pupal counts are given in Table 5. All counts were significantly lower than corresponding check plots. The mean number of pupae/m of burlap trap in the 2.5 L/ha treatments was 12, 14 and 17 compared to 61, 43 and 43 in corresponding check plots. In the 5.0 L/ha treatment the counts were 2, 8 and 11/m burlap trap compared to 37, 43 and 43 in corresponding check plots.

Egg mass counts in the spring and fall are given in Table 5 along with the population reductions due to the treatments calculated using a modified Abbott's formula. Population reductions in the 3 plots treated at 2.5 L/ha were 73, 82 and 90% and at 5.0 L/ha were 87, 91 and 95%.

Defoliation estimates are given in Table 5. There were significant differences in defoliation of all treated plots compared to check plots except in one of the 2.5 L/ha treatments which had 30% defoliation compared to 46% in its corresponding check plot. The remaining two 2.5 L/ha treatments had 34 and 46% defoliation compared to 77% in the check plot with which both were paired. In the 5.0 L/ha treatment defoliation of 29, 31 and 38% was matched with 77, 77 and 93% in corresponding check plots.

Table 5. Assessment of Disparvirus aerial spray trials.

Plot	Emitted volume (L/ha)	Pupae/m burlap (±SE)	Pre-spray EM/ha (±SE)	Post-spray EM/ha (±SE)	% population reduction due to treatment*	% defoliation of oak
Plot 1	2.5	12 ± 2	2280 ± 339	820 ± 164	90	30
Check	-	61 ± 6	2390 ± 471	8200 ± 1376	-	46
Plot 2	2.5	14 ± 2	3620 ± 267	2230 ± 472	73	46
Check	-	43 ± 5	3430 ± 664	7710 ± 1147	-	77
Plot 3	2.5	17 ± 2	3270 ± 588	1340 ± 305	82	34
Check	-	43 ± 5	3430 ± 664	7710 ± 1147	-	77
Plot 4	5.0	8 ± 2	8900 ± 932	1620 ± 244	87	38
Check	-	37 ± 3	6690 ± 1152	9560 ± 1172	-	93
Plot 5	5.0	11 ± 2	4360 ± 809	930 ± 130	91	29
Check	-	43 ± 5	3430 ± 664	7710 ± 1147	-	77
Plot 6	5.0	2 ± 1	3870 ± 572	420 ± 81	95	31
Check	-	43 ± 5	3430 ± 664	7710 ± 1147	-	77

* Calculated using a modified Abbott's formula.

Discussion

It is difficult to make definitive judgments on the basis of 3 plots per treatment and one year of data, but the inference is that the 5.0 L/ha was superior to the 2.5 L/ha using an aqueous tank mix. Using criteria of defoliation not exceeding 40% and post-spray egg mass densities not exceeding 1200/ha, one plot in the 2.5 L/ha treatment suffered 46% defoliation and two plots had post-spray egg mass densities of 1340 and 2230/ha, respectively. In the 5.0 L/ha treatment, all three plots suffered less than 40% defoliation and only one of the 3 plots had a post-spray egg mass density over 1200/ha. This particular plot had the highest pre-spray egg mass density of 8900 which was reduced to 1620/ha.

This was the first time that pheromone traps have been used as part of the assessment of a virus spray application in Canada. The reduction in the number of male moths was not as dramatic as the reduction in egg mass densities. This, however, is to be expected following a virus application, because the virus has a greater impact on female larvae than on male larvae. Female gypsy moth larvae have 6 instars as opposed to 5 for males, leaving the females longer in the larval stage and hence more chance of succumbing to a virus infection than the males.

Conclusions and recommendations

From these results, it appears that a further reduction in emitted volume from 5.0 L/ha to 2.5 L/ha cannot be recommended with any confidence when using this aqueous tank mix containing molasses and Orzan LS. Results with the double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) in 5.0 L/ha continues to be the recommended treatment for Disparvirus.

For Disparvirus to become an operational alternative to *Bacillus thuringiensis*, it will require a Canadian registration and a commercial source of the product. A registration petition for Disparvirus was submitted to Agriculture Canada in April 1990 and is currently being evaluated. FPMI staff have been negotiating with a Maryland company called Espro to establish a pilot plant in the Institute which will be followed in about 2 years by a commercial virus production facility in Sault Ste Marie. Funding is currently being sought from granting agencies. A commercial product will not be available for operational use in 1991, but, along with a Canadian registration, it is hoped that some gypsy moth viral insecticide will be available for use in 1992.

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APPLICATION OF GYPCHEK AGAINST GYPSY MOTH IN ONTARIO IN 1990

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Application of Gypchek against gypsy moth in Ontario in 1990.

J.C. Cunningham, W.J. Kaupp, G.G. Grant, K.W. Brown and D. Frech.

Summary

Gypchek, supplied by the USDA Forest Service, was applied in an emulsifiable oil tank mix. A double application of $5X10^{11}$ polyhedral inclusion bodies (PIB)/ha (total 10^{12} PIB/ha), 7 days apart, in an emitted volume of 5.0 L/ha was targeted on mainly first instar gypsy moth larvae. The tank mix contained 25% Dipel 176 blank carrier vehicle (Abbott Laboratories), 75% water and 0.1% v/v Erio acid red as a tracer. A Cessna Ag-truck with 4 Micronair AU 4000 units was used for the applications on three 10 ha (approx.) plots with pre-spray egg mass densities ranging from 3080 to 7560/ha. These treated plots were paired with 2 check plots which had pre-spray egg mass densities of 2920 and 6690/ha.

In addition to defoliation estimates and egg mass counts, pupal counts in burlap traps and counts of male moths in pheromone traps were used in the assessment of these treatments. All three treated plots met the criteria for a successful application, oak defoliation less than 40% and post-spray egg mass counts less than 1200/ha. Population reductions due to the treatment (Abbott's formula) were 87, 92 and 92%. Defoliation of oak in the treated plots ranged from 29 to 35% compared to 77 and 93% in the two check plots, respectively. Post-spray egg mass counts in the treated plots ranged from 556 to 880/ha. Egg mass densities in the two check plots increased to 4810 and 9560/ha.

Introduction

Aerial spray trials with Disparvirus were conducted in Lindsay District in 1988 and 1989. Results from these trials led to a recommendation of a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) in an aqueous tank mix at 5.0 L/ha. This tank mix contained 25% v/v molasses, 10% v/v Orzan LS and 2% Rhoplex B60A sticker. Although effective, this tank mix is difficult to handle and mix and is unsuitable for operational use.

It was decided to test an emulsifiable oil tank mix and Dipel 176 blank carrier vehicle was supplied by Abbott Laboratories. There was insufficient Disparvirus produced at FPMI for this trial, so Gypchek was supplied by USDA Forest Service colleagues. Gypchek and Disparvirus contain the same strain of gypsy moth nuclear polyhedrosis virus, but are processed in a slightly different manner.

Experimental plots and spray application

Three treated plots, each about 10 ha in area, and two check plots were selected in an area of recent gypsy moth infestation in Simcoe District. Plots were all west of the town of Simcoe and within 25 km of the town.

The same dosage was applied to all 3 plots. This was a double application of $5X10^{11}$ PIB/ha (total 10^{12} PIB/ha) in an emitted volume of 5.0 L/ha. The tank mix contained 25% Dipel 176 blank carrier vehicle (emulsifiable oil) supplied by Abbott Laboratories. The FPMI Cessna Ag-truck was used for both applications. The first was on May 14 and the second was 7 days later on May 22. Meteorological conditions during the applications are given in Table 1. Gypsy moth larvae were mainly in the first instar at the time of both applications and larval development is given in Table 2. Leaves were about 50% expanded on red oak and 25% expanded on white oak at the time of these applications.

Kromekote cards were placed at 15m intervals at right angles to flight lines. This was only feasible in Plot 3. Results of the analysis of these cards are given in Table 3.

Table 1. Meteorological conditions during spray applications.

Date	Air temp at 10m (°C)	Ground temp at 1m (°C)	% RH	Wind km/h
May 14	2.8-7.8	2.3-8.3	93.5-91.8	1.0-2.6
May 22	6.5-8.3	6.0-8.5	82.0-80.0	0-3.0

Table 2. Larval development at time of applications.

Date	%L1	%L2	%L3
May 14	99.8	0.2	0
May 22	81.7	16.1	2.3

Table 3. Spray card deposit on Kromekote cards.

Plot	Application number	NMD (μm)	VMD (μm)	Dmax (μm)	No. of droplets cm^2 (±SE)
3	1	10.8	92.4	159.9	9.3 ± 1.0
	2	20.7	73.3	158.5	2.2 ± 0.5

Assessment

Egg mass counts were made on ten $10m^2$ (0.1 ha) sub-plots in each treated and check plot using methods developed by Forest Insect and Disease Survey staff. Numbers were converted to egg masses per hectare. Counts were made in early May before hatching commenced and the same plots were re-examined in mid-October. Treated and check plots were paired on the basis of pre-spray egg mass densities and reduction in egg mass density was calculated using a modified Abbott's formula.

Pupal counts were made from burlap traps on three oak trees (red or white oak) in each of the 0.01 ha sub-plots used for egg mass counts in all treated and check plots. Strips of burlap 45-cm wide were folded double and nailed to the trunks of trees. The circumference of the trees was measured and pupal counts were converted to pupae/m of burlap trap. Pupal counts were made during the week of July 9-13.

Pheromone trapping was undertaken and 3 traps were placed in each treated and check plot on June 9-10. Lures were supplied by Dr. B. Leonhardt of the USDA Laboratory at Beltsville, Md.; the concentration of pheromone was greatly reduced to avoid excessively high catches in green Multipher gypsy moth traps containing dichlorovos strips to kill the male moths. Traps were hung at 1.5m from the ground and 0.5m from a tree trunk. At the end of the flight period, the traps were removed on Aug. 3 and the catch of male moths counted.

Defoliation estimates were made on 5 red oak or white oak 46-cm branch tips collected at mid-crown from trees in the ten 0.01 ha sub-plots used for egg mass counts. This was done at 8 weeks after the first spray application when larvae had ceased feeding and were either pupating or dead. A total of 50 branch tips was examined in each treated and check plot. An estimate was made of the amount of foliage consumed on each branch and a mean was calculated for the plot.

Results

Pheromone trap counts of male moths are given in Table 4. Compared to the two check plots the reductions in catch in the treated plots were 5, 31 and 37%.

Table 4. Moth catches in pheromone traps.

Plot no.	Mean no. of moths/trap in treated plots (n=3)	Mean no. of moths/trap in corresponding check plots (n=3)	% catch reduction
1	482	767	37
2	526	767	31
3	323	340	5

Pupal counts are given in Table 5. All counts were significantly lower than corresponding check plots. The mean number of pupae/m of burlap trap in one of the Gypchek-treated plots was 3 compared to 9 in its corresponding check plot and 8 and 9 in the other two treated plots compared to 37 in their corresponding check plot.

Egg mass counts in the spring and fall are given in Table 5 along with the population reductions due to treatment, calculated using a modified Abbott's formula, of 87, 92 and 92%.

Defoliation estimates are given in Table 5. There were significant differences in defoliation in all treated plots, 29, 30 and 35% defoliation compared to the two check plots which suffered 77% and 93%

Table 5. Assessment of Gypchek aerial spray trials.

Plot	Emitted volume (L/ha)	Pupae/m burlap (±SE)	Pre-spray EM/ha (±SE)	Post-spray EM/ha (±SE)	% population reduction due to treatment*	% defoliation of oak
Plot 1	5.0	9 ± 2	7560 ± 1574	880 ± 238	92	29
Check	-	37 ± 3	6690 ± 1152	9560 ± 1172	-	93
Plot 2	5.0	8 ± 1	6780 ± 719	750 ± 168	92	35
Check	-	37 ± 3	6690 ± 1152	9560 ± 1172	-	93
Plot 3	5.0	3 ± 1	3080 ± 376	556 ± 279	87	30
Check	-	15 ± 1	2920 ± 552	4810 ± 1181	-	77

* Calculated using a modified Abbott's formula.

defoliation, respectively.

Discussion

Results from the application of Gypchek in an emulsifiable oil tank mix are considered excellent. Both criteria for successful treatment of gypsy moth were met. Defoliation did not exceed 40% in any of the treated plots and post-spray egg mass densities of 556, 750 and 880/ha were well below the target threshold level of 1200/ha.

It was intended to apply the two sprays 3 days apart. However, this was prevented due to unsuitable weather conditions and the second spray was applied 7 days after the first. Insect development had not progressed much during this week and this delay did not adversely affect the final result.

This was the first time pheromone traps were used as part of the assessment of a virus spray application in Canada. The reduction in number of male moths was not as evident as the reduction in egg mass densities. This is probably to be expected because virus applications have more of an impact on female larvae which have 6 instars than male larvae which have 5 instars. There is a higher probability of females dying from a virus infection because they are longer in the larval stage. Pheromone traps are, however, another useful tool in monitoring gypsy moth population densities.

In 1990, trials were also undertaken with Disparvirus produced at FPMI and applied in an aqueous tank mix. It was decided to report these trials separately and make no direct comparisons because 1) the viral insecticides were obtained from different sources, 2) the Disparvirus was applied in an aqueous tank mix and the Gypchek in an emulsifiable oil tank mix and 3) the double Disparvirus applications were 5 days apart and the double Gypchek applications were 7 days apart.

Conclusions and recommendations

The results with the emulsifiable oil were most encouraging and it is certainly easier to handle this tank mix than the aqueous tank mix containing molasses and Orzan LS. The Dipel 176 blank carrier vehicle used as a 25% emulsion was highly effective at 5.0 L/ha and it is recommended that this tank mix be tested with either Disparvirus or Gypchek at 2.5 L/ha in 1991.

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Herbicides Research Conducted by FP-54-1 in 1990

A Report to the 18th Annual Forest Pest Control Forum
(Ottawa, Ontario 20-22 November, 1990)

Phillip E. Reynolds

Project No. FP-54-1 - Weed and Crop Ecology

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Herbicides Research Conducted by FP-54-1 in 1990

Phillip E. Reynolds

Since the last Pest Forum, FP-54-1 has focused its efforts on preparing several manuscripts for journal publication. These manuscripts all relate to crop growth response following site preparation with hexazinone (liquid and granular), metsulfuron, and sulfometuron.

In addition, more research relating to the nature and effects of raspberry competition on crop growth was initiated in 1990. Currently, a research proposal is being prepared for 1991 which will focus on an examination of raspberry competition as it effects sustained growth of planted black or white spruce on clear-cut sites, treated or untreated with herbicides.

Objectives:

The new research has two broad objectives including:

1) a thorough examination of the nature of the competition (i.e., what is being competed for: available nutrients, light, or moisture, and to what extent is each of these factors important in limiting crop growth?) and

2) how long can crop growth increases, resulting from vegetation management, be sustained, without additional intervention?

Progress to Date:

FP-54-1 research on vegetation management of eastern spruce plantations began in 1984, and has continued to evolve to the present time. This work has included site preparation with all formulations of hexazinone and release with glyphosate. Early work focused on herbicide efficacy, crop tolerance and survival, and plant succession. To date, approximately 14 papers have been published on this aspect of the work.

Since 1988, FP-54-1 research has focused on spruce growth response to vegetation management. Specifically, we have sought to understand how growth response is related to differing levels of raspberry competition. Various techniques for measuring above-ground raspberry competition have been examined, and the relationship of spruce growth to raspberry competition has been mathematically examined. To date, 2 growth papers have been published, and 6 journal papers are in various stages of preparation.

Since 1989, FP-54-1's research has focused on developing a better understanding of the nature of the competition. This has included: 1) better quantitation of the competition (i.e., both above- and below-ground biomass) and 2) quantitation of the competition in terms of various factors (i.e., nutrients and light) which have a direct influence on growth.

In 1989, nutrient sampling of white spruce foliage, soil, and of raspberry and fireweed tissues (foliage, canes/stems, and roots) was initiated to better understand the niches of raspberry and fireweed in processing nitrate within clear-cut ecosystems and to determine if crop growth was restricted due to any nutrient deficiencies.

In 1990, nutrient sampling was extended to include a second vegetation management site characterized by severe, rapidly developed raspberry competition. Nutrient sampling included black spruce tissues (i.e., foliage, leader, stem, branches, roots), soil, and above-ground tissues and roots of both cane and trailing raspberry. All sampling was done within a 1-m radius of the sacrificed crop tree. Nutrient analysis, coupled with biomass determination, will provide a better understanding of raspberry competition for nutrients, and of possible impacts of this competition on crop growth.

In 1990, new studies were also initiated to determine the role of raspberry in competing for available light needed to maximize crop growth. Light meter measurements of available light were made for crop trees subjected to varying degrees of raspberry competition ranging from overtopped to free of competition. Light measurements were taken at tree base, mid-tree height, and at leader tip. These measurements were then related to growth response, crop health, and competition levels via regression analysis. Preliminary results strongly suggest that light is probably the major competition factor affecting height growth.

Other data collected to date, suggests that site moisture is probably the major competition factor affecting diameter growth. Nutrient availability is likely influenced by individual site moisture differences, since soil saturation determines whether essential nutrients are readily available in soil solution. Tree photosynthesis is the best overall integrator of these growth factors, since photosynthesis is dependent upon both available light and water.

Proposed Research for 1991 and 1992:

A proposal is currently being prepared for possible funding which seeks to extend competition research begun in 1989. Key facets will include:

1) Extension of nutrient and raspberry biomass research to a third site.

Raspberry biomass estimates for the two sites already studied suggest there is considerable site variability in raspberry biomass and root morphology, and these differences are probably related to significant differences in available water. In order to examine this relationship in greater depth, a third site which is intermediate in soil moisture and raspberry competition will be studied.

We believe there is a definite relationship between soil moisture levels and raspberry biomass and root structure. It appears that raspberry competition develops more rapidly on wet sites, and that root biomass is greater on drier sites. Because of this relationship, nutrient competition is likely to vary widely from site to site.

2) Measurement of soil moisture on three sites which vary widely in available water.

Measurements will be taken at the two sites previously sampled for nutrients and at a third site described above. Measurements of soil moisture will be used to determine more precisely the relationship of crop diameter growth to site moisture conditions. These measurements will also be used to test the validity of a relationship between soil moisture levels and raspberry biomass and root structure. Finally, the measurements will be used in conjunction with tree photosynthesis and transpiration measurements described below.

3) Measurement of crop tree photosynthesis and transpiration on three sites which vary widely in available water and raspberry competition levels.

Measurements of photosynthesis will be taken at the three sites described above. Based upon light competition measurements taken last summer, we plan to model the effects of light competition on crop growth response by estimating available light reaching the tree surface from its leader to its base. Tree photosynthesis measurements will provide a more precise measure of crop productivity in relationship to available light and soil moisture. Transpiration measurements will provide information on plant water uptake in relationship to soil moisture conditions. Photosynthesis and transpiration measurements will be used in multiple regressions which relate crop growth and/or productivity to photosynthetic and transpiration rates, competition levels, crop health, and light, soil moisture, and nutrient availability.

4) Measurement of raspberry photosynthesis and transpiration on three sites which vary widely in raspberry competition levels and soil moisture levels.

A similar approach to that described above will be used.

Publications in 1990:

FP-54-1 journal publications appearing in 1990 include the following.

Feng, J.C., D.G. Thompson, and P.E. Reynolds. 1990. Fate of glyphosate in a Canadian forest watershed. I. Aquatic and off-target deposit assessment. J. Agric. Food Chem. 38: 1110-1118.

Payne, N.J., J. Feng, and P.E. Reynolds. 1990. Off-target deposit measurements and buffer zones required around water for aerial glyphosate applications. Pestic. Sci. 30: 183-198.

Other Activities:

Career development leave for P. Reynolds will be initiated in early 1991 with the U.S. Forest Service Silviculture Laboratory located in Redding, California. The purpose of the leave will be:

1) To gain expertise in alternative silvicultural strategies for controlling competing forest vegetation.

2) To develop a problem analysis for Forestry Canada and FPMI on alternative silvicultural strategies for controlling competing forest vegetation. The problem analysis will be used to define and implement new research directions for FPMI and Forestry Canada in this area.

3) To initiate new research on alternative silvicultural strategies for controlling competing forest vegetation as appropriate.

The Redding Silviculture Laboratory in Redding, California is one of the leading silviculture laboratories in the world involved in the study of competing forest vegetation and the development of operational strategies for the control of this vegetation. Within the U.S. Forest Service, it is the lead laboratory nationally to be charged with this responsibility. Faced with public opposition to chemical herbicide use, the U.S. Forest Service has effectively demonstrated that alternative silvicultural strategies do work, and can be operationally implemented within a relatively short time frame.

Various forestry practices affect the composition and severity of competing vegetation in conifer plantations. These include pre- and post-harvest activities (i.e., prescribed burning, mechanical site preparation, and vegetation management practices), harvest method, and time of harvest. In addition, the composition and density of competing vegetation in young conifer plantations is also influenced by location, stand history, and stand condition at the time of harvest. Hence, alternatives to affect the composition and density of competing vegetation in these plantations are not restricted to direct control (i.e., chemical, manual, mechanical, fire, grazing, combinations thereof) of existing vegetation. By understanding those factors (i.e., environmental, biological, and historical) and forestry practices which determine the composition and intensity of forest weeds competition in young conifer plantations, it is possible to develop stand prescriptions which integrate harvesting and stand regeneration activities. Such prescriptions are capable of preventing or lessening weed competition in new plantations. This indirect approach to vegetation management is proactive rather than reactive, and offers greater flexibility in stand establishment.

Alternative silvicultural strategies for managing competing forest vegetation offer a viable, short-term solution for effectively managing weeds via indirect means. These strategies, along with bioherbicides, are viewed favorably by the public, and are often more readily accepted because of their proactive, preventative stance on forest weeds management as opposed to a reactive, catch-up stance associated with weed problems which have been allowed to develop. In keeping with the reality of the current public attitude on chemical herbicide use, it is important to expand existing programs to include acceptable alternatives. This includes both alternative silvicultural strategies and development of viable bioherbicides. In conjunction with these expanded research programs, FPMI will continue to maintain strong research programs aimed at developing improved use strategies for registered chemical herbicides.

Individuals or organizations having further questions about this research should contact P. Reynolds at FPMI or telephone (705) 949-9461.

BACTERIAL PATHOGENS: UPDATE ON BIOCIDE

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Advances in the genetics and molecular biology of *B.t.* in the early 1980s have resulted in a worldwide interest in biotechnological improvement of *B.t.* Genetic engineering techniques also provide a powerful tool to study toxin structure-function relationships. The Biocide collaborative research network was organized by Paul Fast to capitalize on these developments. The goal of the network is to provide the knowledge base for commercial development of *B.t.* products with enhanced toxicity tailored specifically against forest insects. Since its conception in 1984, collaborators have cloned and sequenced various toxin genes, and have established techniques for obtaining purified toxins that can be used in structural studies, for insertion of site-specific mutations, and for transformation of *B.t.* At FPMI we have developed techniques for *in-vivo* and *in-vitro* bioassay of cloned gene products and have used these techniques to determine activity spectra of toxins. Site-specific mutagenesis is currently being used to improve toxin stability (sunlight degradation and solubility) and to probe the relationship between gene structure and toxin activity (lytic domain) and specificity (binding domain). The latter is also the subject of a collaboration with Ohio State University (Dr. D. Dean) since 1988. A bibliography of Biocide publications and other outputs is available from FPMI.

FOREST PEST MANAGEMENT INSTITUTE SPRAY CLOUD BEHAVIOR PROJECT
1990 FIELD RESEARCH

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Introduction

Field research carried out during the 1990 season included three herbicide-related activities; drift trials under various meteorological conditions using a standard herbicide application method, drift trials using a low-volume herbicide application method, and vegetation assessments for an investigation into the effect of sub-lethal glyphosate deposits on sensitive forest weeds. Two of these investigations were collaborative with outside scientists. Further information is available from the author upon request.

i) Drift trials with standard application method:

To provide baseline data for later comparisons, six trials were carried out to measure airborne herbicide and on- and off-target deposit on foliage and ground sheets exposed downwind of fixed-wing aerial applications using D8 - 46 hydraulic nozzles, a commonly used forestry herbicide application method. A glyphosate mimic tank mix was sprayed at 35 L/ha under various meteorological conditions, and measurements made at downwind distances up to 200 m from the spray line. Meteorological measurements including wind speed, wind direction, air temperature and relative humidity were made in the lower atmospheric boundary layer up to a height of 18 m above ground level. The trials were carried out at the 60 ha FPMI Spray Cloud Behavior experiment site, near Thessalon, Ontario. Dyes were used for spray quantification and deposits are now being measured using fluorometry and image analysis.

ii) Drift trials with low volume application method:

New herbicide application methods were tested in collaborative drift trials with the National Research Council Applied Aerodynamics Laboratory and the Research Branch of the Atmospheric Environment Service. Two trials were carried out in which the airborne cloud and on- and off-target deposits were measured at distances up to 200 m, and the airborne cloud profile was measured at 200 and 400 m from the spray lines. In each trial a Cessna 188 equipped with Micronair AU 5000 rotary atomizers and a dual tank system was used to simultaneously generate clouds with volume median diameters of 100 and 200 µm from two different tank mixes. Meteorological measurements including wind speed, wind direction, air temperature and relative humidity were made in the lower atmospheric boundary layer up to a height of 18 m above ground level. The trials were carried out at the 60 ha FPMI Spray Cloud Behavior experiment site, near Thessalon Ontario. Dyes and organophosphate tracers were used for spray quantification, and deposits which are now being analyzed using fluorometry, gas chromatography and image analysis.

iii) Vegetation assessments:

The final vegetation assessments were made in an investigation to measure the effects of sub-lethal glyphosate doses on sensitive forest weeds. This work has been carried out in collaboration with the University of Guelph Environmental Biology Department, and was funded in part by the Canada-Ontario Forest Resource Development Agreement. This information is needed to establish the buffer zone widths required to prevent herbicide damage to sensitive vegetation as a result of silvicultural glyphosate applications. The data from this investigation will be used in conjunction with herbicide dispersal measurements to scientifically establish buffer widths. Small plots of pin cherry and trembling aspen in the Kirkwood Management Unit, near Thessalon, Ontario were sprayed in 1987 and 1988 at glyphosate application rates between 2 and 100% of the maximum recommended rate for forestry (2.1 kg a.e./ha). Measurements of glyphosate effects were made one and two years after the applications by using the ECW visual scoring technique, leaf and stem growth measurements and shikimic acid analyses by liquid chromatography. Data analysis is now completed, and a manuscript will be submitted to the Weed Science Journal.

RESEARCH ON THE TOXICITY OF INSECTICIDES TO FOREST INSECT PESTS IN 1990

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New Insecticide Development

We have been assessing the potential of 4 new insecticides for the control of forest pests: alpha-terthienyl, RH5992, abamectin and its semi-synthetic derivative, MK-243 in the laboratory. Alpha-terthienyl, a natural phototoxic compound from members of the plant family, Asteraceae, has been tested on several lepidopteran defoliators, sawflies, beetles and weevils previously in collaboration with Dr. J.T. Arnason, U. of Ottawa, Dr. W.J. Kaupp, FPMI, and A. Ceccarelli. In 1990 it was evaluated on gypsy moth larvae but further tests are needed to define its toxicity. Experiments on the effects of near-UV light exposure period on toxicity demonstrated that toxicity increases sharply with longer light exposures up to about 3 hours. Further increases up to 16 h. resulted in relatively small increases in toxicity. To date, all tests have been topical applications followed by exposure to near-UV light. We plan to assess its toxicity to spruce budworm and hemlock looper larvae by ingestion and crawling contact exposure.

RH5992 is a novel insect growth regulating compound discovered and under development by Rohm and Haas. Dr. A. Retnakaran, FPMI, and I have been evaluating this compound against several forest lepidopteran defoliators. I previously examined its toxicity to spruce budworm, eastern hemlock looper and gypsy moth larvae by direct contact and on sprayed foliage as well as its effects on feeding rates in comparison to standard chemical insecticides. RH5992 was very toxic to these pests and reduced feeding quite quickly. I am currently investigating the effects of exposure period to treated foliage on toxicity and the residual toxicity of RH5992 under natural weathering conditions. Abamectin has been isolated from a soil microorganism, Streptomyces avermitilis by the Merck Sharp and Dohme Research Laboratories and is now registered as a miticide in the USA. MK-243, a semi-synthetic derivative of abamectin, has recently been developed and is reported to have very high activity to Lepidoptera. We have just begun testing MK-243 on spruce budworm and hemlock looper larvae in comparison with abamectin. MK-243 appears to be extremely potent to these pests. It is more toxic than abamectin and around 1000X more active than fenitrothion. We plan to expand our screening program against several other forest pests, evaluate its effects on feeding rates and assess its residual toxicity.

Pine False Webworm

In 1990, D.B. Lyons, Forestry Canada, Ontario Region, and I collaborated in laboratory and field trials to develop an insecticide control strategy for the pine false webworm on red pine. Laboratory bioassays with 10 common, registered insecticides were carried out with newly hatched larvae on sprayed red pine branches. Carbaryl and permethrin were the most effective at low dosages. Field trials were then conducted with Ambush 500EC (permethrin) at 35, 70 and 2x35 gAI/ha, and Sevin XLR Plus (carbaryl) at 125, 250, 500 and 2x125 gAI/ha applied by mistblower in a red pine plantation. The double application of both insecticides and the 2 highest dosages of Sevin reduced larval numbers and defoliation.

Seedling Debarking Weevil

For the past three years we have been conducting insecticide bioassays with *Hylobius congener* adults in cooperation with Bruce Pendrel, Forestry Canada, Maritimes Region. The residual effectiveness of permethrin, chlorpyrifos and fenitrothion for protecting conifer seedlings for up to 2 years is being evaluated by spraying or dipping potted white spruce and red pine seedlings with selected concentrations of these insecticides, placing the seedlings outdoors and exposing weevils to them at yearly intervals. In 1990, two-year bioassays were conducted on red pine seedlings and one-year bioassays on spruce. Sprays of 1% permethrin and 2.5% chlorpyrifos provided the greatest protection.

Cone Beetles

We are screening insecticides against *Conophthorus* cone beetles in collaboration with P. deGroot. To date, fenitrothion, carbaryl, dimethoate, lindane, permethrin and azinphos-methyl have been tested on red pine cone beetle and white pine cone beetle adults by topical application. Both species were also exposed to branches dipped in permethrin.

Black-headed Budworm

We also conducted preliminary insecticide bioassays on black headed budworm, *Acleris variana* this year. Fourth-instar larvae appeared to be slightly more susceptible to contact sprays of MATACIL and fenitrothion than fifth-instar spruce budworm larvae.

White Pine Weevil

For several years we have been assessing the potential of pyrethroids, particularly permethrin, for the control of WPW adults in the laboratory with encouraging results. In 1990, P. deGroot, FPMI, and I collaborated in conducting a field trial to assess the effectiveness of permethrin in protecting leaders of jack pine from weevil attack. Further information on this trial is provided in a separate report.

WHITE PINE WEEVIL CONTROL RESEARCH TRIALS IN ONTARIO

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White pine weevil, Pissodes strobi (Peck), has become a serious pest in many jack pine and black spruce plantations in Ontario and elsewhere. Jack pine and black spruce are two of the most important tree species in the tree improvement and reforestation programs in Canada. Spring applications of methoxychlor and leader clipping have been used, with varying success, to control damage by the weevil. In some plantations leader clipping is neither practical nor feasible, and in some high value stands, such as seed orchards or family tests, leader clipping is not desirable. Variable results with methoxychlor applications have usually been attributed, post hoc, to poor spray coverage, lack of persistence, or late timing, but scientific studies to investigate the performance of methoxychlor are few. Laboratory studies with the pyrethroid insecticide permethrin also indicated that it had good potential to control this pest. Therefore, the purpose of our study was to develop an effective control method for the control of white pine weevil in seed orchards and other high value stands where little or no leader loss is wanted. Reported here are the preliminary analyses of the bioassay and damage appraisal data from spray trials with methoxychlor and permethrin.

A jack pine plantation near Garden Lake, north of Sault Ste. Marie, Ontario was selected and divided into three blocks. Within each block, 16 50-tree plots were established. Four treatments, permethrin at 70 g and 140 g AI/ha, methoxychlor at 1 kg/ha, and an unsprayed control, were randomly assigned to four plots in each block. Calibrated Solo back pack sprayers, equipped with flat fan spray nozzles and pressure regulators, were used to apply the insecticides to the leader of each tree. The insecticides were applied on 4 May 1990, about 6-7 days after most of the snow had melted away from the base of the trees and 2-3 days after the snow melted from the site. The incidence of oviposition up to 4 May and consequent damage was determined by placing fiberglass window screen cages over the leaders of 35 untreated trees in each block on treatment day and examining these for damage in October. An additional 30 trees were sprayed with each insecticide on 4 May for bioassays. At weekly intervals, laboratory-maintained weevils were caged on three randomly chosen trees per treatment, to bioassay the residual effectiveness of the insecticide treatments. From 17 May to 4 July, four plots for each treatment were visited at biweekly intervals to monitor the incidence of leader damage. Beginning 12 July all 2400 trees were examined biweekly for leader damage; a final assessment was made on 17 September.

Weevil survival on the leaders treated with insecticides in the bioassay experiment was generally less than 5% for 6 weeks after treatment compared to 96% in the untreated controls. Thereafter, survival increased, probably due in part to the presence of new shoots which had not been treated. Weevil survival, between 7 to 10 weeks post-spray, was lowest in the methoxychlor treatment, followed by the 140 g and 70 g AI/ha treatments with permethrin. Oviposition was much lower on insecticide-treated leaders than the untreated control leaders. For example, a total of 440 eggs were laid on the control leaders during the 10-week bioassay period, while only 7 eggs were laid in the 70 g AI/ha permethrin treatment between the 7th and 10th week of the bioassay.

The results of the final assessment of leader damage in the treatment blocks are shown in Table 1. Clearly all three insecticides provided good leader protection. No significant difference in the level of leader protection (P=0.05) was found between the three insecticide treatments, but all insecticide treatments had significantly lower damage levels than the untreated control (Kruskal-Wallis, one-way ANOVA, with multiple comparisons, BMDP software package).

These preliminary analyses suggest that permethrin and methoxychlor can give good levels of weevil control when applied early by ground spray equipment. Additional studies to assess timing and persistence are planned for 1991.

Table 1. Leaders destroyed by white pine weevil 20 weeks after treatment with permethrin and methoxychlor, Garden Lake, Ontario, 1990

Treatment (g AI/ha)	Percent destroyed leaders, x ± SE Treatment Block 1	2	3	Pooled
Permethrin (70)	3.5 ± 1.0	1.5 ± 1.0	1.0 ± 0.6	2.0 ± 0.6
Permethrin (140)	1.0 ± 0.6	5.0 ± 0.6	7.0 ± 1.9	4.3 ± 1.0
Methoxychlor (1000)	1.5 ± 0.5	2.0 ± 0.8	2.5 ± 0.5	2.0 ± 0.3
Untreated control	13.5 ± 4.6	15.5 ± 3.7	16.5 ± 1.7	15.2 ± 1.9

INSECT GROWTH REGULATOR UPDATE FOR 1990

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Insect growth regulators (IGRs) belong to a new generation of pesticide called biorationals. Various classes of these compounds are being developed to control insects by interfering with their growth and development. **Chitin inhibitors** alter the normal development of cuticle and hence the molting process itself. **Juvenile hormone analogs** interfere with the normal growth of insect larvae and eventually prevent pupation. The most recent class of IGRs is the **ecdysonoid**. These compounds mimic the molting hormone ecdysone and are responsible for stimulating precocious molting in exposed larvae. All of these new classes of compounds are being tested in both the laboratory, under controlled conditions, and in the field.

The 1990 field season was reserved for the testing of Dimilin, a chitin inhibitor, against the white pine weevil and for initial probes of the ecdysonoid, RH-5992, against the spruce budworm.

In the laboratory, work is continuing on attempts to isolate and use a microsporidian plasmid as a vector to insert deleterious genes for insect control.

WHITE PINE WEEVIL STUDIES

Field studies using Dimilin against the white pine weevil were carried out in three different locations including Sault Ste. Marie. In Quebec, a research plot has been established for conducting an intensive five year study of the habits of white pine weevil and of the potential of Dimilin as a control agent for this insect. Back-pack sprayers were used to spray trees individually, in one part of the plot, and to cover larger blocks in another part of the area. Both approaches produced positive results, however, the data was distorted slightly due to a period of unseasonally warm weather and early insect activity in the test area, which unfortunately resulted in delayed spraying. Experimental success with IGRs depends on delivering the material to the target insect prior to mating. The early spring put us about one week behind schedule and some mating occurred before the IGR was applied. Instead of 100% damage control, we noticed as much as 11% of the leaders to be weeviled.

In Maine field studies were carried out using both ground spraying and aerial approaches. These trials are being spearheaded by Dr. John Diamond with the cooperation of Uniroyal, the North American distributor of Dimilin. All ground spray applications conducted by Dr. Diamond over the years using Dimilin have provided almost 100% damage control when applied before the onset of mating activity as per our instructions. To date, the aerial spraying has not proven effective. In defense of these aerial attempts, none of them have been started until the insect was well into its mating season. This is a problem that keeps recurring when trying to employ contract help. In an effort to rectify this problem, we are presently tryiny to make arrangements to have our own spray plane available for the 1991 spray attempt in Maine.

In Sault Ste. Marie, ground spray trials were conduced to coincide with the work being done in Quebec. Similar spray equipment was used to deliver a dose of Dimilin to the leader of the test tree. As in Quebec, an early spring warm spell induced mating activity prior to the spray taking place. Like Quebec, we were about one week behind schedule and our results mirrored theirs with about 11% of the trees receiving weevil damage to the leaders.

SPRUCE BUDWORM TRIALS

Earlier trials with molt inhibitors were largely unsuccessful against the spruce budworm. Recently, our laboratory assessment of a new ecdysonoid, RH-5992, indicated that the spruce budworm was extremely sensitive to low doses of this material. In 1990, small ground spray trials were conducted in the Gaspé peninsula using this new material. The experimental plots were located at a high elevation and exposed to extremes of dehydration and cold. The insect population initially was plentiful and robust, but, the rigors of that location took its toll. The results of the work indicated high incidence of precocious molting with total control and very little defoliation. The controls showed some defoliation but the results could be improved next year.

LABORATORY INVESTIGATIONS

Today, environmental concerns are pushing research in new and interesting directions. New approaches to insect control are employing the techniques and technology of molecular biology. We are in the process of isolating the microsporidian parasite, Nosema disstria, from the MD66 cell line of the forest tent caterpillar (Malacasoma disstria). From microsporidia we hope to isolate a plasmid into which we can splice a gene such as the *B.t.* gene or a neurohormone gene. The new plasmid would hopefully possess the toxic capacity of *B.t.* or produce large amounts of the hormone and when inserted back into the microsporidia would make the transgenic microsporidian an effective control agent.

SUMMARY REPORT ON STUDIES CONDUCTED BY THE FOREST PEST MANAGEMENT INSTITUTE'S ENVIRONMENTAL IMPACT PROJECT IN 1990

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Aquatic Impact Studies

Benthos and Brook Trout Population Assessments in Icewater Creek

The project to determine secondary effects on brook trout of an insecticide treatment was continued. An initial treatment in 1987 (permethrin at peak concentration of 11 µg/L) resulted in significant short-term depletion of benthos, but no effects on trout density, movement, condition, or population age structure, and equivocal effects on growth of young trout. Significant reductions in the growth rates of young trout in 1987 were attributed, at least partially, to temperature stress from unusually high summer temperatures in that year. The treatment was repeated on 6 June 1990 (peak permethrin concentration of 10.5 µg/L), and the sampling regime from previous years was continued through the season. The abundance and composition of benthos was measured at several sites in the treated area at 5 week intervals from mid-May to late September. Mechanisms of benthos recolonization were measured at one of the sites by more frequent sampling in drift-restricted, drift and oviposition-restricted, and unaltered areas. The population density and age structure, movement of individuals, growth rates and production of brook trout were also measured three times between May and November. Mean daily water temperatures in 1990 were considerably lower than in 1987, and approached the pretreatment (1984-1986) mean temperatures. The data are being analyzed and should provide a measure of the secondary effects on trout of benthos reductions after an insecticide treatment, in the absence of temperature stress.

Development and Operation of a Lab Flow-Through Bioassay for Stream Insects

In cooperation with the Biology Department of Lake Superior State University (LSSU), a flow-through bioassay system was developed and operated at the LSSU Aquatics Lab in Sault Ste. Marie, Michigan, for testing the toxicity of forestry pesticides to stream insects. The system is a modification of one originally developed by Rodrigues and Kaushik at the University of Guelph, and was developed specifically to test the toxicity of two herbicides (hexazinone and trichlopyr) and one *B.t.k.* formulation to stream insects. The system will be maintained for future testing of other pesticides, however. Stream insects were collected from local streams, transported to the aquatics lab, and acclimated for 24-48 h before exposure to the pesticides. In the herbicide bioassays, the insects were treated for 1 h at a constant concentration, and observed for 48 h. In the *B.t.k.* bioassays, the insects were exposed to a constant concentration for 24 h, and observed for 9 d. All insects were initially exposed to the test material at a concentration of 100X the expected environmental concentration (EEC - based on a direct deposit of the maximum application rate on a 50 cm column of standing water). If no mortality occurred in a test species (corrected for control mortality), the LC50 was considered to be >100X the EEC, and no further testing was conducted. If mortality of a test species occurred at 100X the EEC, further testing was conducted to determine a dose-response curve and an LC50 estimate. From June to November 1990, 12 species of stream insects were tested with the herbicides (Velpar L and Garlon 4), and 9 species were tested with *B.t.k.* (Dipel 8AF). Results are being analyzed, but preliminary data analyses indicate that none of the 12 species exposed to Velpar L were affected, nor were the 9 species exposed to Dipel 8AF. Of the 12 species exposed to Garlon 4, 3 exhibited mortality at concentrations less than 100X the EEC, and a dose-response was generated for those test species.

Pesticide Effects on Invertebrates in a Stream-side Channel

The effects of Velpar L, Garlon 4, and Dipel 8AF on aquatic invertebrates were determined in stream-side bioassay channels. In this system, water is diverted from Icewater Creek through two artificial stream channels where the behavioural and lethal effects of pesticides on stream insects are measured. The design allows for determining pesticide effects on insect drift, on survival of drifters, and on survival of insects that do not drift in response to the pesticide exposure. The system can concurrently test two concentrations, each with three treatment and three control replicates of two species. The herbicide treatments consisted of a 1 h constant concentration exposure followed by observations at 1, 3, and 24 h. The *B.t.k.* treatments consisted of a 2½ h constant exposure followed by observations and mortality checks up to 7 d. As in the laboratory bioassay procedure, test species were initially exposed to pesticide concentrations of 100X the EEC, and further testing at lower concentrations were conducted if a response occurred at the higher concentration. From mid-July to early October 1990, effects of Velpar L and Garlon 4 on 7 species of stream insects were determined, and the effects of Dipel 8AF on 5 species were measured. Results from these trials are being analyzed.

Terrestrial Invertebrate Studies

Laboratory studies were continued with non-target Lepidoptera as part of both the work reported last year regarding effects of *B.t.* on availability of food for birds (cooperating with R. Millikin and J. Bendell), as well as a new, cooperative initiative to develop laboratory bioassay protocols for testing microbial insecticides. This latter work currently involves S. Holmes, B. Helson, K. Barber, and V. Kaupp all from FPMI.

One important aspect of this work involves rearing species which feed upon lowbush blueberry, *Vaccinium angustifolium*, originally taken from jack pine plantations. A considerable amount of effort has been applied to the development of a rearing methodology for *Itame brunneata* (Geometridae), which is one of the most common species feeding on blueberry, and which is known to comprise part of the diets of nestling songbirds and chicks of spruce grouse. Five artificial (defined) diets have been tested and none are satisfactory in producing healthy, late-instar caterpillars, as over 85% mortality is suffered along with prolonged developmental periods and undersized pupae compared to those reared on blueberry foliage. The alternative of establishing first-instar larvae on Bell diet (used for gypsy moth) and then transferring to clipped blueberry foliage in the late-second or early-third instar worked well in small-scale trials but the transition to large-scale met with excessive mortality and equivocal bioassay assessments arising from high mortality in control animals. It is unlikely that this problem will be solved easily, but attempts will be made to incorporate ground, freeze-dried blueberry foliage into Bell diet, sometime in the spring. We can now reliably rear *Xylena thoracica*, *Eupsilia tristigmata*, *Metalepsis salicarum*, and *Orthosia revicta* - all are noctuids. Bioassays will be conducted with the first three species within the next few months and will include *B.t.* and gypsy moth NPV. Work with *Orthosia revicta* awaits re-establishment of the laboratory culture.

Work is also continuing on the development of an oral pesticide delivery system for *Megachile rotundata* (alfalfa leafcutter bee). To date, it appears that direct "nursing" of individual bees holds the greatest promise as the preferred delivery system while headway has been made in fine-tuning a post-treatment maintenance system that can reliably sustain small groups of bees in excess of three weeks.

Other work has been, and will continue to be, done in developing rearing and bioassay methodologies for other nontarget and beneficial insects. This will include parasites and predators as well as a more extensive selection of nontarget Lepidoptera.

Terrestrial Vertebrate Studies

The study leader for Terrestrial Vertebrate Studies at FPMI (R.L. Millikin) is presently on temporary assignment with the Canadian Wildlife Service in British Columbia, where she is acting as Forestry/Wildlife Program Development Liaison Officer. The objectives of this Science and Technology Exchange Program (STEP) initiative are: 1) to transfer expertise from FPMI to CWS in the area of environmental impact monitoring, 2) to establish a research program in B.C. to assess the effects of regional forest pest management practices on forest songbird populations, and 3) to coordinate CWS and Forestry Canada inputs into this program.

Microcosms Studies

FPMI has recently initiated a research program aimed at developing standard protocols for testing the fate and environmental effects of microbial forest pest control agents in laboratory model ecosystems (microcosms). This program is being developed in consultation with Canadian pesticide regulatory authorities (Departments of Agriculture and Environment), in order to ensure that information generated in microcosm studies with candidate forestry pesticides is acceptable for registration purposes. To date, work has focussed primarily on establishing a research network of various government departments and Canadian universities, and developing and testing a range of sensitive detection techniques (DNA probes, ELISA) for microbial products (*B.t.* spore and crystal, viral DNA).

EFFICACY OF DIPEL 352 (DIPEL 16L) AGAINST SPRUCE BUDWORM: A SUMMARY OF PRELIMINARY RESULTS*

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A trial was conducted in the Black Sturgeon River district in NW Ontario to determine the efficacy of Dipel 352 (Dipel 16L) against moderate to high (25-62 larvae per 45 cm branch) populations of spruce budworm Choristoneura fumiferana (Clem.). The product was applied undiluted at 30 BIU/ha (0.9 L/ha) using a Cessna Ag Truck fitted with 4 AU4000 rotary atomizers. Three 100 ha blocks, two for the B.t. treatments and the other as a control, were used. One block was sprayed at a "regular" time (peak L_4) and the other 9 days later when the larvae were peak L_5. Sixty balsam fir Abies balsamea and 60 black spruce Picea mariana were selected randomly per block as sample trees and two 45 cm branches at each sampling (1 pre and 2 to 3 postspray).

The spray deposit ranged from 2.1 to 3.8 drops/cm^2 on kromekote cards and 0.1 to 0.28 drops per needle (n = 50) on spruce and balsam fir foliage.

The block sprayed at the "regular" time showed a corrected budworm population reduction of 34% and 31% on balsam and spruce respectively. In the block that was sprayed "late", the population reductions on balsam and spruce were 56% and 64% respectively.

Defoliation on balsam was 88% and 70% in the "regular" and "late" blocks respectively; whereas on black spruce it was 26% and 35% in the "regular" and "late" blocks, respectively. In the control block 87% of the balsam foliage was defoliated and 26% of the black spruce.

At budworm populations >30 per 45 cm branch the data from this trial suggest that a late application of Dipel 352 was more effective in suppressing the insects than the regular one. However the level of foliage protected by Dipel 352 did not differ significantly from that in the untreated block and was generally unsatisfactory.

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*The data are very preliminary and must not be published nor cited without the permission of the Director General, FPMI.

STUDIES ON THE ENVIRONMENTAL CHEMISTRY OF FORESTRY INSECTICIDES

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INTRODUCTION

The Insecticide Chemical Accountability Project has two primary objectives: (1)to study the distribution, persistence, toxicity and fate of forestry insecticides in different components of the forest environment and (2)to develop adequate analytical capabilities to identify and quantify trace levels of the residue moieties present in various forestry matrices. In addition, cooperative interactions with the scientists here and elsewhere, form a viable approach to solve some of the challenging problems facing chemical control methods in forestry and thereby yielding rewarding results. This report summarizes some of the achievements made in the research activities conducted during 1989/90.

(1) Distribution, deposition and persistence of *Bacillus thuringiensis* (kurstaki) [*B.t.*(k)] in a deciduous forest environment

Undiluted Novo Forav 48B *Bacillus thuringiensis* (k) formulation was sprayed in May 1990 over four blocks of a deciduous forest with oak stands in the Hawley area of eastern Pennsylvania at two dosage rates in duplicate at 20 BIU/53 US oz per acre (50 BIU/1.57 L per hectare) and 30 BIU/80 US oz per acre (75 BIU/2.37 L per hectare). Prespray and postspray oak foliage and simulated oak foliage samples were collected at intervals of time and stored in alkaline buffer with NaN$_3$ for assaying the concentration levels of *B.t.*(k) (60 kilodalton, kDa) toxin. *B.t.* deposits in ground samplers (glass-fiber discs mounted on collection units and alkaline buffers in petri-dishes) were also collected at 1 h postspray. Droplet densities (droplets/cm^2) and droplet size distributions (NMD, VMD, D$_{max}$ and D$_{min}$) were measured at canopy and ground levels using Ciba-Geigy water sensitive papers (10 mm x 26 mm) mounted or fastened onto supports.

Gypsy moth larvae were bioassayed (force-feeding) against the alkaline buffer extract of the formulation (Novo Foray 48B) and a calibration curve (% mortality *vs* concn. of 60 kDa) was prepared. Pre- and postspray *B.t.*(k) extracts of simulated and natural oak foliage samples and ground deposit samplers (exposed buffer and simulated foliage) were bioassayed and the mortalities of the larvae determined. Using the calibration curve, the concentration of the 60 kDa *B.t.*(k) in the analytes were established. The concentrations of the 60 kDa *B.t.*(k) in different extracts were also quantified by using an enzyme-linked immunosorbent assay (ELISA) developed cooperatively by the author and Dr. D.B. Hammock (Univ. Calif., Davis, CA). The ELISA studies are in progress and involves the coating of the microtiter plates successively with goat anti *B.t.*(k), addition of analyte [*B.t.*(k) extract], addition of rabbit anti *B.t.*(k), goat anti-rabbit IgG (enzyme labeled) and developing an yellow colour for spectroscopic quantification with addition of a substrate. Using the bioassay and ELISA data, the distribution and persistence of *B*.*t*.(k) as 60 kDa will be evaluated.

(2) Force feeding bioassays of *Bacillus thuringiensis* kurstaki [*B*.*t*. (k)] on spruce budworm

A study comparing enzyme-linked immunosorbent assay (ELISA) to force feeding bioassays on ten [*B*.*t*.(k)] formulations and their buffer extracts (pH 12) has recently been completed in Davis, California. The force feeding bioassays were completed using first day sixth instar spruce budworm larvae. A minimum of 50 control larvae were dosed with the buffer solution. For each formulation or extract, three assays were carried out with a minimum of seven dosing levels and ten larvae per level. After four days the failure to produce frass was determined. The data was then examined by probit analysis. The bioassay work is very time-consuming in comparison to the ELISA method. The data is now being statistically analyzed to compare the two methods and the extracts to their corresponding formulation.

(3) Control of seed and cone insects in black spruce, *Picea mariana* (Mill.), by trunk implantation of acephate as Acecap capsules

A collaborative experiment with NeF scientists is being performed in 1988 to 1990 for control of seed and cone insects [spruce cone maggot, cone worms *Diorytria* spp, axis midge, *Desineura rachiphaga* Tripp; and the spruce cone worm *Cydia strobilella* (L)] by implanting black spruce trees at the time of bud flush with gelatin capsules containing acephate (Acecaps). As an initial step, a sensitive GLC analytical method was developed to detect and quantify acephate and its metabolite methamidophos from the barks, seeds and cones of black spruce. The steps involved in the methodology are chopping the individual matrices, macerating to small pieces in a Sorvall Omni-mixer, homogenizing twice with EtOAc in a Polytron generator, filtering through a Na_2SO_4 column, flash-evaporating the crude extract to a small volume at 30°C (if necessary partitioning with ACN and hexane to remove lipid materials present in seeds), column cleanup using Nuchar/cellulose, elution with EtOAc, concentration of the clean extract under N_2 and analyzing by capillary GC with a N specific detector. Recoveries of fortified samples were above 90% and detection limit of the parent and metabolite was at 0.01 ppm.

Acephate and methamidophos residues in different matrices analysed were interpreted in terms of insect reduction and enhanced seed production in black spruce. Although acephate degraded with time, the combined effect of the parent material and equally toxic metabolite, methamidophos, were effective in controlling the seed and cone insects in black spruce. Residue analyses and data evaluation for the 1990 study are in progress and a final report of the three year study will be made either during this winter or spring of 1991.

(4) Fate, persistence, partitioning and accumulation of permethrin in a forest stream environment

Data gaps have been identified for permethrin insecticide relating to its use in forestry situations. Environmental fate data including its uptake, accumulation, persistence and dissipation in aquatic components, especially under forest stream environment, are lacking. During the early part of this summer, a study was undertaken to fill up some of the data gaps by injecting (1.66 g) an aqueous emulsion of permethrin (Ambush 50 E.C.) to a fast flowing headwater stream in N. Ontario. Water samples, periphyton from blocks and stream rocks and invertebrate drift of three sizes, small, medium and large were collected at intervals of time for analysis of permethrin residues. The concentration in stream water increased from 0.22 ppb (20 min post-application at 220 m from the treatment site) to 2.71 ppb (30 min after application) and decreased rapidly to non-detectable levels (0.005 ppb) within 270 min after treatment. The concentrations of permethrin in periphyton increased to peak levels of 11.29 ppb (plastic sheets on cement blocks) after 90 min and dissipated gradually to below the detection limit (0.75 ppb) after 13 d whereas the concentration of permethrin in periphyton from rocks reached a peak level of 9.80 ppb after 3 h, lingered at that concentration for another 4 h and dissipated rapidly after 7 d to below the detection limit. Periphyton exhibited a large capacity for the sorption of the pesticide from surrounding water and acted as a sink for the chemical. The peak concentrations of the insecticide in small, medium and large invertebrate drift and the corresponding postspray time intervals were: small, 63.6 ppb at 0.92 h; medium, 39.6 ppb at 0.92 h; and large, 30.1 ppb at 0.92 h. The residues diminished gradually and no residues were found in small, medium and large insects drifted after 2 d, 1 d and 12 h respectively. The study demonstrated that aquatic invertebrates and stream periphyton acted as sinks for the chemical. Among the invertebrate drift, insect size, lipid content, and morphology appear to be important factors in determining the capacity for permethrin absorption.

(5) Analysis of bound insecticide residues in forest soil and foliage under laboratory conditions

The potential of supercritical fluid extraction (SCFE) and high-temperature distillation (HTD) techniques for the release of bound residues from forest soil and foliage is currently being examined using three different insecticides, aminocarb, diflubenzuron and fenitrothion. The insecticides were applied to sandy loam soil and balsam fir foliage at a 10 ppm (μg/g) fortification level (^{14}C-labeled to act as a tracer) and the samples were then left undisturbed in a simulated environment. After 7 days, the samples were collected and frozen at -20°C until laboratory analysis. Any $^{14}CO_2$ which may have evolved during the duration of the study was collected using soda lime columns for subsequent analysis.

The samples collected are being extracted by conventional methods as well as by oxidation, SCFE and HTD techniques. The SCFE and HTD apparatus used in this study have been developed in-house by modifying existing laboratory equipment. Quantitative analysis of the final results will be made by gas chromatography, high-performance liquid chromatography and liquid scintillation counting. A comparison of the different methods of analysis will be made from the results and the nature and extent of bound residues in the forestry substrates and their bioavailability will be determined.

(6) Influence of foliar morphology and surface characteristics on the droplet reception and retention of insecticides

In a recent study it was demonstrated that at a dosage of 70 g/ha, trembling aspen, Populus tremuloides, foliage contained 4.542 µg/g of permethrin at 1 hour postspray, that is on average nearly 50% more than the needles of jack pine, Pinus banksiana, (3.466 µg/g), white pine (3.125 µg/g) and white spruce (2.573 µg/g), probably because of the greater surface-to-volume ratio of the aspen compared to conifers. Also the morphology of foliage and its surface characteristics played key roles in droplet reception and retention during spray applications. The initial bark residue level was also much higher in aspen (1.646 µg/g) than in the barks of jack pine (0.818 µg/g), white pine (0.240 µg/g) and white spruce (0.409 µg/g). Residues in all samples decreased rapidly at the beginning and then gradually: measurable levels persisted over winter including the fallen aspen foliage collected from the forest floor. The following table gives the residue levels in samples collected 363 days postspray as well as the DT50 and DT90 values:

Substrate Type	Concn. (µg/g) (363 d values)	DT_{50} (days)	DT_{90} (days)
aspen foliage	0.661*	6.95	40.4
aspen bark	0.029	5.02	31.7
jack pine needles	0.037	7.13	25.0
jack pine bark	0.048	4.23	17.8
white pine needles	0.021	6.54	21.4
white pine bark	0.021	6.93	24.6
white spruce needles	0.039	5.72	24.7
white spruce bark	0.017	5.19	22.7

* collected from forest floor

The amount of initial deposits found in conifers was influenced to a large extent by the geometry of tree crown, needle density and configuration. Furthermore, the collection efficiency of conifer needles and the impaction potential of the droplets in the vicinity of the targets would have played some role. Dissipation patterns and residual lives in needles, apart from the initial permethrin levels found in them, are to some degree influenced by the type and amount of lipoidal content of the matrices.

In another experimental spray program, the phosphamidon residue levels in 1 year old needles of balsam fir, white spruce, white pine, red pine, Pinus resinosa, and jack pine, and in fresh foliage of white birch, Betula papyrifera, and red maple were determined at intervals of time after application. The 1 hour postspray peak residue levels and the corresponding DT_{50} values are given in the following table:

Foliar Type	Concn. (μg - fresh wt.)			DT$_{50}$ (days)		
	cis	trans	total	cis	trans	total
balsam fir	0.830	2.030	2.860	1.74	3.53	2.94
white spruce	0.317	0.839	1.156	2.95	3.30	3.20
white pine	0.364	0.931	1.295	1.58	1.78	1.72
red pine	0.406	1.102	1.508	2.39	2.40	2.39
jack pine	0.677	1.706	2.383	1.89	2.45	2.24
white birch	1.446	3.906	5.352	3.39	4.00	3.84
red maple	1.974	4.706	6.680	3.88	5.63	5.06

Residues were lost rapidly and exponentially, with the exception of jack pine. Other conifers did not contain any residues beyond 40 d postspray. Jack pine and the foliage from the two deciduous species contained detectable levels beyond 40 days. Various physical factors and metabolic processes such as dealkylation, hydrolytic cleavage of the ester bond and dechlorination would have operated in concert on the chemical to reduce its concentration. The less toxic cis form is lost more rapidly than the trans isomer. The persistence of a chemical is dependent on the nature of the matrix and the initial concentration found in it. This is illustrated by the higher DT$_{50}$ values for phosphamidon in birch and maple foliage than in conifers. Within the conifers, the initial deposition, retention and subsequent degradation patterns of the chemical are to a large extent influenced by many interrelated factors such as the geometry and density of tree crown, needle configuration and the type and amount of cuticular waxes present in the needles. It appears that needle configuration plays a vital role in the droplet reception either by sedimentation or impaction or by both processes.

SUIVI ENVIRONNEMENTAL DES PULVÉRISATIONS DE PESTICIDES SUR LES FORÊTS PUBLIQUES DU QUÉBEC EN 1990

Rapport préparé pour le 18^e Colloque annuel
sur la répression des ravageurs forestiers
tenu à Ottawa le 20, 21 et 22 novembre 1990

Sylvie Delisle
Jean Cabana
Jean Legris
Pierre M. Marotte

GOUVERNEMENT DU QUÉBEC
MINISTÈRE DE L'ÉNERGIE ET DES RESSOURCES
SERVICE DES ANALYSES ENVIRONNEMENTALES

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INTRODUCTION

Depuis plusieurs années, les forêts publiques du Québec font l'objet de traitements à l'aide de différents pesticides. Le Service des analyses environnementales du ministère de l'Énergie et des Ressources du Québec a le mandat d'évaluer les impacts de l'utilisation de ces produits sur l'écosystème forestier. Il doit aussi évaluer les conséquences sur la santé humaine et s'assurer de l'utilisation sécuritaire des pesticides. Pour atteindre ces objectifs, le Service réalise des études permettant de suivre l'évolution des pesticides dans l'environnement. Il exerce également une surveillance lors des opérations relatives à l'épandage de ces produits.

Le document qui suit résume les activités du Service concernant le suivi environnemental et le contrôle de la qualité des insecticides utilisés par le ministère de l'Énergie et des Ressources pour lutter contre la tordeuse des bourgeons de l'épinette. On y retrouve aussi les différentes études portant sur le suivi des phytocides employés lors de la préparation de terrains destinés au reboisement et lors de l'entretien des plantations.

SUIVI ENVIRONNEMENTAL DES INSECTICIDES

par S. Delisle

Depuis quatre ans, le ministère de l'Énergie et des Ressources du Québec (MER) n'utilise que des insecticides biologiques à base de *Bacillus thuringiensis* var. *kurstaki (B.t.)* pour lutter contre la tordeuse des bourgeons de l'épinette. En 1990, la superficie couverte par les pulvérisations opérationnelles correspond à 479 942 hectares de forêts situées dans le Bas-Saint-Laurent et la Gaspésie. Près de 45% de cette superficie a reçu deux traitements successifs au cours du programme d'épandages. Les produits utilisés sont, par ordre d'importance, le Dipel^{MD} 176, le Futura XLV-HP^{MD}, le Foray 48B^{MD} et le Biodart^{MD}. Les traitements ont été faits à une dose de 30 M.U.I./hectare dans des volumes respectifs de 1,77, 0,90, 2,37 et 1,77 litres/hectare.

Les pulvérisations d'insecticides biologiques introduisent des quantités importantes de spores viables de *B.t.* dans le milieu forestier. Ces spores sont susceptibles de persister et de s'accumuler avec le temps. Elles auraient même la capacité de se multiplier en présence de conditions favorables. Dans le but d'acquérir plus de connaissances sur le devenir du *B.t.* dans l'environnement, le Service des analyses environnementales effectue chaque année des études sur le comportement de cette bactérie dans différents milieux. Il réalise également un contrôle de la qualité des préparations d'insecticides avant leur utilisation.

1. PERSISTANCE DES SPORES DE *B.T.*

a) Persistance du Thuricide^{MD} 48LV dans le sol après cinq ans

En 1985, le MER a entrepris d'étudier la persistance à long terme des spores de *B.t.* dans le sol de secteurs traités au Thuricide^{MD} 48LV. Initialement, 29 stations de sol forestier avaient été établies pour réaliser cette étude. Depuis, ces stations ont été échantillonnées annuellement. Plusieurs d'entre elles ont été abandonnées au fil des ans pour diverses raisons, dont le fait qu'elles avaient de nouveau été exposées aux pulvérisations de *B.t.* En 1990, l'étude s'est poursuivie avec l'échantillonnage de onze stations permettant de déterminer la quantité de spores résiduelles après cinq ans. Les portions organique et minérale du sol ont été prélevées séparément pour un total de 22 échantillons.

b) Persistance et accumulation dans le sol

Jusqu'à cette année, peu de données nous renseignaient sur l'accumulation des spores de *B.t.* dans le sol après plusieurs traitements annuels consécutifs. Pour en savoir davantage, le Service a identifié deux secteurs de forêt ayant été traités à plusieurs reprises par le passé et qui devaient l'être de nouveau en 1990. Dix-sept stations de sol forestier y ont été établies pour ensuite être échantillonnées avant le début des opérations, d'un à trois jours suivant chaque application ainsi que trois mois plus tard. Les horizons organique et minéral du sol ont été échantillonnés avant les opérations et après le délai de trois mois alors que seul le sol organique a été prélevé dans les jours suivant la pulvérisation du produit. Pour cette étude, 56 échantillons de sol organique et 34 de sol minéral ont été recueillis.

c) Persistance du Foray 48B^{MD} dans le sol après un an

En 1989, une pulvérisation expérimentale de Foray 48B^{MD}, de la compagnie Novo, a fait l'objet d'une étude de persistance. Ce suivi consistait en l'échantillonnage de seize stations de sol forestier réparties à l'intérieur de deux aires d'une superficie de 36 hectares. Le comportement à court terme de ce nouveau produit avait alors été vérifié entre un et trois jours après le traitement ainsi qu'après un délai de trois mois.

Dans la continuité de ce suivi, des prélèvements de sol ont été fait à ces stations en 1990. Cet échantillonnage visait à évaluer la persistance à plus long terme des spores de *B.t.*, soit onze mois après l'application de Foray 48B^{MD}. Les sols organique et minéral ont été recueillis séparément pour un total de 32 échantillons.

d) Persistance dans l'eau et les sédiments de lacs

Depuis trois ans, le Service étudie la persistance des spores de *B.t.* dans huit lacs situés à l'intérieur de secteurs traités au Dipel^{MD} 132 en 1987. L'année suivante, quatre lacs ont été de nouveau exposés à des pulvérisations de *B.t.* Parmi ces derniers, deux lacs ont été exposés au produit pour une troisième année consécutive, en 1989. Depuis 1987, des échantillons d'eau et de sédiments ont été prélevés annuellement dans chacun des huit lacs. Le but de cette étude, est de vérifier si les concentrations augmentent en fonction du nombre d'applications et d'autre part, si elles diminuent avec le temps. En 1990, 24 échantillons d'eau et 40 échantillons de sédiments ont été prélevés pour cette étude.

2. DÉPÔT À L'EXTÉRIEUR DES AIRES TRAITÉES

Depuis quelques années, les insecticides biologiques sont pulvérisés en gouttelettes de dimensions inférieures à ce qu'elles étaient auparavant. Cette diminution du diamètre laisse envisager la possibilité d'une dérive du produit en dehors des secteurs de pulvérisations. Une étude sur le dépôt au sol a donc été réalisée cette année afin d'évaluer les quantités de spores de *B.t.* retrouvées jusqu'à un kilomètre des aires traitées. Cette projet a aussi permis de vérifier la protection accordée aux zones sensibles.

Cent vingt-sept échantillons ont été recueillis lors de dix-sept opérations d'épandage différentes effectuées par des avions quadrimoteurs ou monomoteurs.

3. SUIVI DES ZONES SENSIBLES

a) Eau potable des bases d'opérations

L'eau potable des bases d'opérations alimentées par des puits est analysée chaque année dans le but d'y déceler une éventuelle contamination. Les bases desservies par un aqueduc municipal ne font l'objet d'aucun suivi. En 1990, l'eau potable des bases de Rivière-du-Loup et de Bonaventure a été analysée. En tout, vingt échantillons ont été récoltés.

b) Eau potable des municipalités

La présence du *B.t.* a été vérifiée dans l'eau potable des villages de Maria et de La Rédemption en Gaspésie. Ce contrôle a été réalisé parce que la prise d'eau potable de ces municipalités se trouvait à moins de cinq kilomètres des aires traitées. Des échantillons ont été prélevés au robinet d'eau chlorée des stations de pompage avant le début des pulvérisations et par la suite dans une séquence s'étalant de 0,5 à 56 jours. Douze échantillons ont été recueillis à chaque station.

c) Pisciculture

Cette année, seule la pisciculture de l'Anse-Pleureuse, située à neuf kilomètres des aires traitées, a fait l'objet d'un suivi après des pulvérisations de *B.t.* Cette étude visait à vérifier la présence des spores dans l'eau de la pisciculture étant donné que les épandages touchaient le bassin versant du cours d'eau alimentant cet établissement. La séquence de récolte a commencé avant le début des opérations et s'est poursuivie jusqu'à 56 jours après les pulvérisations. Cinq échantillons ont été prélevés lors de ce suivi.

4. CONTRÔLE DE LA QUALITÉ DES PRÉPARATIONS DE *B.T.*

par J. Cabana

Avant le début des pulvérisations opérationnelles, tous les lots de *B.t.* ont été échantillonnés afin d'y rechercher la présence de microcontaminants pathogènes et de vérifier le titre insecticide des produits.

Trente-sept espèces de micro-organismes autres que le *B.t.* ont été identifiées. Les espèces *Enterococcus faecalis* et *Enterococcus faecium* n'ont été retrouvées que dans les lots de Dipel^{MD} 176 reçus en 1990. Les résultats du dénombrement des entérocoques révèlent des concentrations variant de < 33 à 14 540 U.F.C./ml. En 1989, ces concentrations variaient de < 33 à 267 U.F.C./ml. À l'exception des entérocoques, aucune espèce indicatrice de contamination désignée par Agriculture Canada n'a été détectée par le laboratoire. Les concentrations d'entérocoques sont demeurées sous la limite aceptée par Agriculture Canada.

Tous les lots de produits utilisés ont démontré un titre insecticide acceptable selon l'étiquette. Toutefois, dans le cas du Biodart^{MD}, le Ministère n'a pu utiliser que 31% des 42 miniconteneurs de 1000 litres (bulkdrums). En effet, le reste du produit présentait un titre insecticide trop faible pour être pulvérisé à la dose indiquée sur l'étiquette. Dans le cas du Futura XLV-HP^{MD}, un phénomène de décantation du produit dans les barils a été observé à la fin du mois de juin.

En résumé, tous les lots de *B.t.* ont d'abord été approuvés lors du contrôle de la qualité avant d'être utilisés.

SUIVI ENVIRONNEMENTAL DES PHYTOCIDES

par J. Legris

En 1990, 11 751 hectares ont été traités par voie terrestre à l'aide de phytocides. Environ 75 % de cette superficie correspond à des plantations de résineux dégagées avec du glyphosate. Le reste des travaux visait à préparer le terrain avec de l'hexazinone, en vue d'un reboisement. Toutes ces opérations ont eu lieu en forêt publique.

Afin de valider et de compléter nos connaissances sur le comportement des phytocides utilisés en milieu forestier par ou pour le Ministère, le Service des analyses environnementales a effectué, en 1990, un suivi environnemental du glyphosate (Vision^{MD}) et de l'hexazinone (Velpar L^{MD}). Mentionnons que plusieurs suivis ont déjà été réalisés sur le glyphosate depuis 1985. Comme l'utilisation de l'hexazinone s'accroît depuis les dernières années, une emphase a été mise sur le suivi de ce produit dans les différentes composantes du milieu.

1. GLYPHOSATE

a) Eau et sédiments

L'application terrestre du glyphosate se fait généralement avec des pulvérisateurs de type Boomjet^{MD}. Durant ces travaux, une bande de protection de 25 mètres est respectée le long des cours d'eau afin d'éviter leur contamination. De l'eau et des sédiments ont déjà été prélevés au cours des suivis antérieurs et en général, aucun résidu détectable n'a été observé. Afin de s'assurer que ces résultats sont constant d'une année à l'autre, sept échantillons de sédiments ont été récoltés en bordure des secteurs traités. Six autres échantillons ont aussi été recueillis là où des résidus avaient été décelés en 1988 et en 1989 lors de vérifications semblables. Mentionnons toutefois que ces prélèvements positifs reflètent souvent des conditions d'opération particulières (ex.: précipitation importante après le traitement et bande de protection non respectée).

Par ailleurs, afin de poursuivre une étude sur la persistance du produit dans les sédiments, six échantillons ont été recueillis dans des petites mares ayant été exposées à des pulvérisations aériennes en 1987.

En forêt privée, certains groupements forestiers appliquent le glyphosate avec des rampes agricoles. Théoriquement, cet équipement produit généralement moins de dérive que les pulvérisateurs de type Boomjet^{MD}. À cause d'un manque de données pratiques sur les épandages avec rampes, les mêmes bandes de protections sont actuellement recommandées lors de l'utilisation des deux systèmes de pulvérisations. Afin de vérifier l'impact d'une réduction éventuelle des bandes de protection lors des opérations avec rampes, quelques prélèvements d'eau et de sédiments ont été faits dans des cours d'eau protégés par des bandes de cinq et dix mètres.

b) Déversements

Certains sites où sont survenus des déversements accidentels de glyphosate lors de travaux réalisés depuis 1987 ont été échantillonnés. Vingt-quatre prélèvements de sédiments et treize de sol ont été recueillis cette année dans le cadre de ces suivis.

c) Dépôt et dérive

Afin d'améliorer et de compléter les données permettant d'établir la largeur des bandes de protection en regard des techniques d'application utilisées, des études de dépôt et de dérive ont été réalisées. Des applications expérimentales ont été faites à l'aide d'un hélicoptère et d'un avion munis de buses à jet plat et de buses à jet conique avec cône de turbulence. Ces essais ont été effectués lorsque les vents étaient pratiquement nuls et lorsqu'ils variaient de 8 à 10 km/h. Mentionnons que la limite recommandée pour de telles opérations est actuellement de 8 km/h. Au total, 920 stations ont été échantillonnées à l'aide de plats de Pétri (analyse colorimétrique) et de papiers Kromekote ^{MD}.

Des vérifications semblables (même nombre d'échantillons) ont aussi été faites lors de pulvérisations terrestres effectuées avec des rampes agricoles et des pulvérisateurs de type Boomjet^{MD} équipés de buses OC20 modifiées.

d) Lavage des vêtements de protection

À la suite d'une étude du Centre de toxicologie du Québec terminée en 1989 sur l'efficacité du lavage à l'eau froide pour éliminer le glyphosate sur les vêtements de travail, il a été possible cette année de travailler avec des habits en tissus pour certains postes de travail. Toutefois, afin de vérifier les concentrations de résidus retrouvées dans les eaux de lavage de ces vêtements et d'améliorer la gestion de ces dernières, huit échantillons provenant des deux premières eaux de lavage ont été prélevés. En attendant les résultats de cette étude, il est recommandé d'intégrer ces eaux à la bouillie lors du mélange du produit.

2. HEXAZINONE

a) Eau et sédiments

Le suivi des résidus d'hexazinone en milieu lotique a été effectué dans l'eau et les sédiments de sept ruisseaux. Des échantillons d'eau ont été prélevés jusqu'à 0,5 km des secteurs traités, à l'intérieur d'un délai d'un mois après le traitement. Compte tenu de la solubilité et de la mobilité du produit dans l'eau, une attention particulière a été accordée à l'influence des précipitations. Au total, 71 échantillons ont été recueillis. Par ailleurs, les sédiments présentant une texture fine ont également été prélevés dans ces ruisseaux. Quatorze échantillons ont ainsi été récoltés dans les premiers jours suivant le traitement et après environ cinq mois.

Dans d'autres secteurs traités, des vérifications ponctuelles ont été réalisées dans l'eau et les sédiments. Ainsi, onze prélèvements d'eau et quatre de sédiments ont été récoltés au cours du premier mois suivant les traitements.

En milieu lentique, deux mares exposées directement à des applications d'hexazinone ont fait l'objet d'un suivi. Dans chacune de ces mares, une douzaine d'échantillons d'eau et huit échantillons de sédiments ont été prélevés au cours des cinq premiers mois suivant les pulvérisations.

Par ailleurs, afin de vérifier la persistance du produit dans les sédiments de ruisseaux, six stations ayant révélé la présence de concentrations en 1989 ont de nouveau été échantillonnées cette année.

b) Sol et végétation

L'échantillonnage dans le sol forestier des strates 0-10cm et 10-20cm s'est poursuivi dans un secteur traité en 1989 avec des pulvérisateurs de type Boomjet^{MD}, lors de la préparation de terrain avant le reboisement. Ces données permettront de préciser le comportement et la persistance du produit dans ce substrat.

La présence de résidus a été vérifiée dans les ramilles, le feuillage et les fruits de diverses espèces pouvant être utilisées par l'homme et la faune. Trente-quatre échantillons ont été récoltés dans des secteurs traités en 1989 et en 1990.

c) Suivi des travailleurs

Dans le cadre de son programme de surveillance biologique des travailleurs forestiers utilisant des phytocides, le Ministère a poursuivi son entente avec le Centre de toxicologie du Québec. L'exposition des travailleurs à différents modes d'application de l'hexazinone a été mesurée à partir du dosage dans l'urine. Cent soixante-quinze échantillons ont été récoltés lors de cette étude.

3. SURVOL AÉRIEN

Finalement, le Service a réalisé un survol en hélicoptère des secteurs traités avec l'hexazinone ou le glyphosate afin de vérifier la qualité des pulvérisations (efficité et respect des bandes de protection). Ce survol a aussi permis de qualifier l'évolution de la croissance de la végétation après les traitements.

ENVIRONMENTAL MONITORING OF PESTICIDE SPRAYING IN PUBLIC FORESTS IN QUEBEC IN 1990

Report prepared for the
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INTRODUCTION

In recent years, Quebec's public forests have been treated with a variety of pesticides. The Environmental Analysis Service of the Quebec Department of Energy and Resources is responsible for assessing the effect of the use of these products on forest ecosystems. It is also charged with evaluating their impact on human health and ensuring they are used safely. To achieve these objectives, the Service conducts studies to monitor the fate of pesticides in the environment. It also carries out monitoring during operational pesticide spraying.

The following document summarizes the activities of the Service respecting the environmental monitoring and quality control of insecticides used by the Department of Energy and Resources to control the spruce budworm. It also contains a number of studies on the monitoring of herbicides used in preparing sites for reforestation and in tending plantations.

ENVIRONMENTAL MONITORING OF PESTICIDES

by S. Delisle

For the past four years, the Quebec Department of Energy and Resources (MER) has used exclusively the biological pesticide *Bacillus thuringiensis* var. *kurstaki (B.t.)* to control the spruce budworm. As part of an operational spray program conducted in 1990, 479,942 hectares of forests located in the Lower St. Lawrence and Gaspé regions were treated. Close to 45% of this area received two successive treatments under the program. The products used, in decreasing order of importance, were Dipel® 176, Futura XLV-HP®, Foray 48B® and Biodart®. The pesticides were applied at 1,77, 0.90, 2.37 and 1.77 litres/ha respectively to deliver 30 BIU/ha.

The spraying of biological insecticides introduces large amounts of viable *B.t.* spores into the forest. These spores are likely to persist and accumulate over time. Under favourable conditions, they would even be able to multiply. With the objective of acquiring more data on the fate of *B.t.* in the environment, the Environmental Analyses Service conducts studies each year on the behaviour of this bacteria in different environments. It also conducts quality control of insecticide preparations before their use.

1. PERSISTENCE OF *B.t.* SPORES

(a) Persistence of Thuricide® 48LV in soil after five years

In 1985, MER undertook a study of the long-term persistence of *B.t.* spores in the soil of sectors treated with Thuricide® 48LV. Twenty-nine forest soil stations were initially established and sampled annually. Several of the stations were abandoned over the years for various reasons, including re-exposure to *B.t.* spraying. In 1990, the study continued with the sampling of 11 stations to determine the quantity of residual spores after five years. The organic and mineral components of the soil were sampled separately for a total of 22 samples.

(b) Persistence and accumulation in the soil

Until this year, there has been little data on the accumulation of *B.t.* spores in soil after several consecutive annual treatments. To obtain further data, the Service identified two forest sectors that had been treated several times in the past and which was to be treated again in 1990. Seventeen forest soil stations were established in the sectors and were sampled before operations began, one to three days after each application, and again three months after each application. The organic and mineral horizons of the soil were sampled before the operations and three months after spraying, whereas only the organic soil was sampled within days of the spraying. Fifty-six samples of organic soil and 34 samples of mineral soil were taken for this study.

(c) Persistence of Foray 48B® in soil after one year

In 1989, experimental spraying of Foray 48B®, manufactured by Novo, was the subject of a study to monitor the persistence of the pesticide. This study consisted in sampling 16 forest soil stations located within two 36-hectare areas. The short-term behaviour of this new product was then determined one to three days after the treatment and again three months later.

As part of this monitoring study, soil samples were taken at the stations in 1990 to evaluate the longer-term persistence of *B.t.* spores 11 months after the application of Foray 48B®. Organic and mineral soil samples were collected separately for a total of 32 samples.

(d) Persistence in water and lake sediments

For three years, the Service has been studying the persistence of *B.t.* spores in eight lakes located in sectors treated with Dipel® 132 in 1987. The next year, four of the lakes were re-exposed to *B.t.* spraying, and of that four, two were exposed to *B.t.* for a third consecutive year in 1989. Water and sediment samples have been taken annually in each of the eight lakes since 1987. The purpose of this study is to determine whether concentrations increase as a function of the number of applications and also whether they decrease with time. In 1990, 24 water samples and 40 sediment samples were taken for this study.

2. OFF-TARGET DEPOSITION

In the past few years, biological insecticides have been sprayed in smaller droplets than was previously the case. The smaller droplet size gives rise to the possibility of off-target drift. As a result, a soil deposition study was conducted this year to assess the quantities of *B.t.* spores detected up to one kilometre from the target areas. This project also made it possible to determine the level of protection given to sensitive areas.

One hundred and twenty-seven samples were collected during 17 different aerial spray operations carried out by four-engine or single-engine planes.

3. MONITORING OF SENSITIVE AREAS

(a) Drinking water of operational bases

The drinking water of operational bases supplied by wells has been analyzed annually in order to detect possible contamination. No monitoring is done at bases served by a municipal water supply system. In 1990, the drinking water of the bases of Rivière-du-Loup and Bonaventure were analyzed. A total of 20 samples were taken.

(b) Drinking water of municipalities

The drinking water of the municipalities of Maria and La Rédemption in the Gaspé was tested for *B.t.* These tests were conducted because the drinking water intakes of these municipalities were located less than five kilometres from the treated areas. Samples were taken at the chlorinated water valve of pumping stations before spraying was begun and a series of samples were taken 0.5 to 56 days after spraying. Twelve samples were collected at each station.

(c) Fish farming

This year, the fish farm at Anse-Pleureuse, located nine kilometres from the treated areas, was the only one to undergo monitoring following *B.t.* spraying. The purpose of the monitoring was to test the water of the fish farm for spores since the spraying had affected the watershed of the body of water that supplies this establishment. The sampling began before the beginning of operations and continued until 56 days after the spraying. Five samples were taken for this study.

4. QUALITY CONTROL OF *B.t.* PREPARATIONS

by J. Cabana

Before the commencement of the operational spraying, all lots of *B.t.* were sampled in order to test for the presence of pathogenic microorganisms and to verify the insecticide concentration of the products.

Thirty-seven species of microorganism other than *B.t.* were identified. *Enterococcus faecalis* and *Enterococcus faecium* were found only in lots of Dipel® 176 received in 1990. The results of the counting of enterococci reveals concentrations ranging from < 33 to 14,540 CFU/ml. In 1989, these concentrations ranged from < 33 to 267 CFU/ml. With the exception of the enterococci, no contamination indicator species designated by Agriculture Canada were detected by the laboratory. The concentrations of enterococci were below the limits accepted by Agriculture Canada.

All lots of products used had an acceptable insecticide concentration in accordance with the label. However, in the case of Biodart®, the Department was able to use only 31% of the 42 1,000-litre bulkdrums. The insecticide concentration of the rest of the product was too low to be sprayed at the rate indicated on the label. In the case of the Futura XLV-HP®, settling of the product in the drums was observed in late June.

In brief, all lots of *B.t.* were approved by quality control before they were used.

ENVIRONMENTAL MONITORING OF HERBICIDES

by J. Legris

In 1990, 11,751 hectares were treated with herbicides applied from the ground. Approximately 75% of this area was coniferous plantations released with glyphosate. The rest of the activities were aimed at preparing the site for reforestation using hexazinone. All operations were carried out in public forests.

In order to confirm and complement our data on the behaviour of herbicides used in forests by or for the Department, the Environmental Analyses Service conducted environmental monitoring of glyphosate (Vision®) and hexazinone (Velpar L®) in 1990. A number of monitoring programs had already been conducted on glyphosate since 1985. Since the use of hexazinone has been on the rise in recent years, emphasis was placed on the monitoring of this product in the various components of the environment.

1. GLYPHOSATE

(a) Water and sediments

Ground application of glyphosate is generally carried out using Boomjet® sprayers. A 25-metre buffer zone is left along bodies of water to prevent their contamination. Water and sediment samples had already been taken during previous monitoring programs and, in general, no detectable level of residue was found. In order to ensure that these results are constant from year to year, seven sediment samples were taken along the periphery of the treated areas. Six other samples were taken at sites where residue was detected in 1988 and 1989 during similar determinations. It should be noted, however, that these positive samples often reflect specific operating conditions (for instance, heavy rain after treatment and failure to maintain a buffer zone).

Moreover, in order to study the persistence of the product in sediments, six samples were taken in small ponds that had been exposed to aerial spraying in 1987.

In private forests, a number of forest associations apply glyphosate with agricultural booms. Theoretically, this equipment generally produces less drift loss than Boomjet® sprayers. Owing to the lack of practical data on boom application, the same buffer widths are currently recommended for the two application methods. In order to determine the impact of reducing the buffer zones during boom operations, several water and sediment samples were taken in the bodies of water protected by 5- and 10-metre buffer widths.

(b) Spills

A number of sites at which accidental spills of glyphosate have occurred during operations conducted since 1987 were sampled. Twenty-four sediment samples and 13 soil samples were taken this year as part of these monitoring programs.

(c) Deposition and drift

In order to improve and complement data required to determine the width of buffer zones for various application methods, deposition and drift studies were conducted. Experimental spraying was carried out using a helicopter and plane equipped with flat-fan nozzles and cone nozzles with a disk core. These tests were conducted under conditions of virtually no winds and in 8 to 10 km/h winds. The recommended limit for such operations is currently 8 km/h. A total of 920 stations were sampled using petri dishes (colorimetric analysis) and Kromekote® papers.

(d) Washing protective clothing

Following a study by the Centre de toxicologie du Québec completed in 1989 on the effectiveness of cold-water washing to remove glyphosate from protective clothing, it was possible to work with fabric clothing for certain work stations this year. To determine the residue concentrations found in the wash water of the clothing and to improve the management of wash water, eight samples of water from the first two washings were sampled. Pending the results of this study, it is recommended that the water be mixed in with the spray mixture during the preparation of the product.

2. HEXAZINONE

(a) Water and sediment

The monitoring of hexazinone residue in lotic systems was conducted in water and sediment from seven streams. Water samples were taken up to 0.5 km from the treated areas, within one month of treatment. Given the solubility and mobility of the product in water, special attention was focussed on the effect of precipitation. A total of 71 samples were taken. Fine sediments were also sampled in these streams. Fourteen samples were taken in the days immediately following the treatment and again roughly five months later.

In the other treated areas, specific determinations were carried out in the water and sediment. Eleven water samples and four sediment samples were taken within one month of the treatments.

In lentic systems, two ponds directly exposed to the hexazinone applications were monitored. In each pond, 12 water samples and 8 sediment samples were taken within five months of the spraying.

In order to determine the persistence of the product in stream sediments, six stations at which concentrations had been detected in 1989 were sampled again this year.

(b) Soil and vegetation

The sampling of forest soil at soil depths of 0 - 10 cm and 10 - 20 cm continued in an area treated in 1989 with Boomjet® sprayers in preparation for reforestation. This data will be used to determine the behaviour and persistence of the product in this stratum.

The twigs, foliage and fruit of various species that might be used by man or wildlife were tested for residues. Thirty-four samples were taken in the sectors treated in 1989 and 1990.

(c) Monitoring of workers

Under its biological monitoring program for forest workers using herbicides, the Department pursued its agreement with the Centre de toxicologie du Québec. The exposure of workers to different hexazinone application methods was determined using urinalysis. One hundred and seventy-five samples were taken for this study.

3. FLY-OVER

The Service flew over the areas treated with hexazinone or glyphosate in a helicopter in order to determine the quality of spraying (effectiveness and maintenance of buffer zones). This fly-over also made it possible to qualify changes in the growth of vegetation after treatment.

Role and Mandate of the National Forest Pest Control Forum

The National Forest Pest Control Forum has been in existence since 1973 and represents the only national meeting when all forest pest management and pesticide specialists can meet to exchange information and discuss issues concerning their current year and forecast programs. The Forum replaced the long-standing Interdepartmental Committee on Forest Spraying Operations which carried out a similar function but with little or no provincial representation. The Interdepartmental Committee was originally formed to review and recommend federal involvement in and funding of pest control operations carried out in the late 1950's and 1960's.

In recent years, the Forum has permitted an exchange of information concerning pest management operations and research. This has been the principal function of the Forum.

At the Forum meeting at Ottawa, November 19-21, 1985, a Forum Mandate Review Committee was proposed because there were several attendees who felt that the Forum could and should be more than an information exchange session. The committee, consisting of B.T. McGauley (OMNR), G. Munro (MDNR), L. Dorais (QMER), G.M. Howse (CFS) and E. Kettela (CFS) was subsequently endorsed by the Director General, Research and Technical Services. The terms of reference for the committee as outlined in a letter dated December 17, 1985 from the Program Manager, Protection, to the Director General were as follows:

i) examine the mandate of the Annual Forest Pest Control Forum,

ii) consider a change in the mandate of the Forum,

iii) if a change to the mandate is considered necessary, make recommendations for implementation of a change,

iv) discuss and make recommendations for broadening of the Forum to include vegetation management research.

The committee met in May and August 1986 to address the terms of reference and prepare a proposed goal and mandate statement for presentation at the 1986 Forum. The proposal was debated at length and modified to take into consideration the comments of the attendees. The modified role and mandate as agreed upon at the 1986 National Forest Pest Control Forum are outlined in this paper.

1.0 National Forest Pest Control Forum:

A National Forest Pest Control Forum will be conducted each year under the aegis of the Canadian Forestry Service.

2.0 Goal:

The goal of the Forum is to review significant pest conditions, pest control operations and pest management/pesticide related issues.

The word "pest" is interpreted in its broader context and includes insects, diseases and weeds. Pesticides include insecticides, fungicides and herbicides.

3.0 Activities of the Forum:

The National Forest Pest Control Forum will undertake the following activities:

1. exchange information on significant insect and disease distribution and forecast spread in Canada;
2. review the pest management activities, environmental monitoring, assessment of current year insect and disease control programs, overview of the herbicide program and outline of issues relating to any pesticides;
3. outline pest control operations proposed for the next calendar year;
4. apprise of current research relating to pesticide application, pesticide and silvicultural or other research which would reduce future pest outbreak potential;
5. receive an annual update on forestry pesticides which are registered and pending registration and discuss product by product the gaps preventing full registration by Agriculture Canada;
6. gather statistical information from each province in a standardized format (to be developed federally and agreed to by the provinces) on the operational forest pesticide use (ground and aerial);
7. debate specific pest management/pesticide issues and present recommendations in an Executive Summary.

4.0 Membership:

A significant change in the activity of the Forum is point #7 in Section 3.0. A Steering Committee will be needed to prepare issue statements for discussion. The Forum attendees will debate the issues openly and then vote. Motions which are carried will constitute recommendations which will be included in the Executive Summary which attendees can subsequently use as they see fit.

4.1 STEERING COMMITTEE MEMBERS:

Provincial forestry representatives: .1 from each of 10 provinces

Canadian Forestry Service: .1 from each of 2 institutes
.1 from each of 6 regional establishments
.2 from CFS Headquarters

Executive Secretary: .FIDS - CFS Headquarters

5.0 Attendance at the Forum:

The following will be invited:

- provincial pest control staff
- provincial and federal government health, wildlife, fisheries and oceans, and environment staff
- border-state and federal U.S. pesticide/pest control staff
- federal government survey, research and pesticide regulatory staff
- representatives of the forest industry, both at the organizational and company level
- researchers
  - provincial government
  - private research labs
  - universities and colleges
- others as approved by the voting membership (e.g. Eastern Spruce Budworm Council representative, forestry consultants).

The following will not be invited:

- media
- environmentalist groups
- pesticide industry representatives.

6.0 Forum Outputs:

6.1 Annual Report:

The Forum provides an opportunity for information exchange and as such, will continue to produce an Annual Report. The Annual Report will contain detailed written submissions by participants, a list of attendees and addresses and an executive summary with recommendations (see below). Each member of the steering committee will receive 2 copies of the Annual Report (one copy catalogued in a library and the other retained by the member) and one copy will be sent to each attendee. Those who are absent but entitled to an invitation (see Section 5.0) will receive a copy if a written request is received.

6.2 Executive Summary:

An executive summary (2-3 pages) will be prepared each year by the steering committee and include a brief overview of insect/disease distribution, pest management programs, and proposed pest management programs, plus a significant treatment of issue statements with recommendations. The executive summary will be distributed to Forum attendees and be included in the Annual Report.

7.0 Modus Operandi:

The Forum program will be chaired cooperatively by the federal and provincial program assistants (see Section 8.0).

8.0 Program:

Detailed reports of pest control programs and research will be required for the Annual Report. However, the Forum program will be streamlined to permit additional time for discussion. The existing time frame of 3 days of reports and workshops will be retained. The 3-day program will include a half-day on operational pest control reports, half-day on pest distribution, half-day on research, environmental monitoring and health concerns, and a half-day on issue debate and preparation of recommendations. With this tight time frame, it will be necessary for speakers to be focused and brief. Speakers will touch on highlights and identify issues which could be discussed during the issue debate period.

The program will be prepared by the Executive Secretary with assistance from the provincial representative and corresponding CFS representative. It is recognized that some CFS organizations span several provinces and may be called upon more frequently than others. The Ontario Ministry of Natural Resources and Great Lakes Forestry Centre will assist the Executive Secretary in 1987. Future program organizers are proposed as follows:

YEAR	ORGANIZERS	CFS
1	Ontario	Sault Ste. Marie
2	British Columbia	Victoria
3	Quebec	Quebec
4	Alberta	Edmonton
5	New Brunswick/P.E.I.	Fredericton
6	Saskatchewan	Edmonton
7	Nova Scotia	Fredericton
8	Manitoba	Edmonton
9	Newfoundland	St. John's

9.0 Location:

The Forum will remain in Ottawa in 1987 and 1988. However, in 1988 serious consideration should be given to holding the Forum in other provinces on an annual basis beginning in 1989.

10.0 Date:

The Forum should continue to be held during the third week of November.

11.0 Budget:

The Forum will continue to function under the aegis of the Canadian Forestry Service and incidental expenses (e.g. postage, publication of proceedings, meeting room) will be covered by the Federal government.

Rôle et mandat du Forum national sur la répression des ravageurs forestiers

Le Forum national sur la répression des ravageurs forestiers, créé en 1973, est la seule occasion, pour tous les spécialistes de la lutte antiparasitaire au pays, de se rencontrer pour échanger des renseignements et discuter de leurs programmes en cours et prévus. Il remplace l'ancien Comité des fonctions semblables, mais au sein duquel les provinces étaient peu ou pas représentées. A l'origine, le Comité avait pour mission d'étudier et de recommander la participation du gouvernement fédéral à la lutte antiparasitaire et à son financement, durant la fin des années 1950 et les années 1960.

Ces dernières années, le Forum a permis d'échanger des données sur les ravageurs, la lutte qu'on leur fait et la recherche dans le domaine; il s'agit de sa principale fonction.

Lors du Forum qui s'est tenu à Ottawa du 19 au 21 novembre 1985, les participants ont proposé la création d'un comité d'étude du mandat du Forum, car, pour plusieurs d'entre eux, la recontre pouvait et devait être plus qu'une séance d'information. Le comité, formé de B.H. McGauley (MRNO), de L. Dorais (MERQ), de G.M. Howse (SCF) et de E. Kettela (SCF), a ensuite été appuyé par le directeur général, Services techniques et recherche; d'après la lettre (du 17 décembre 1985) du gestionnaire du Programme de protection au directeur général, il était chargé:

(i) d'étudier le mandat du Forum annuel sur la répression des ravageurs forestiers;

(ii) d'envisager sa modification;

(iii) si elle est nécessaire, de faire les recommandations pertinentes;

(iv) de discuter de la possibilité d'étendre le mandat du Forum à la recherche sur l'aménagement des végétaux et de faire les recommandations pertinentes.

Le Comité s'est recontré en mai et en août 1986 pour étudier la question; il a préparé un énoncé qui a été débattu en 1986 et modifié en fonction des observations des participants. Voici donc un aperçu du rôle et du mandat nouveaux.

1.0 Forum national sur la répression des ravageurs forestiers:

Il sera tenu, chaque année, sous les auspices du Services canadien des forêts.

2.0 Objet:

Étudier les principaux ravageurs, la lutte qu'on leur fait et les questions connexes (lutte/pesticides).

Le mot "ravageur" est utilisé dans son acception la plus large et englobe les insectes, les maladies et les mauvaises herbes; les pesticides incluent les insecticides, les fongicides et les herbicides.

3.0 Activités:

Les activités du Forum sont les suivantes:

1. Échanger des renseignements sur la répartition et la progression prévue des infestations et des maladies importantes au Canada;

2. Passer en revue la lutte antiparasitaire, la surveillance de l'environnement, l'évaluation des programmes de lutte contre les insectes et les maladies (année en cours), les grandes lignes du programme d'épandage d'herbicides et l'aperçu des questions relatives au pesticides;

3. Énoncer les mesures de lutte proposées pour la prochaine année civile;

4. Évaluer la recherche actuelle (épandage de pesticides, pesticides comme tels, sylviculture, etc.) qui permettrait de réduire les possibilités d'infestations futures;

5. Recevoir une mise à jour annuelle des pesticides forestiers homologués et en voie de l'être; discuter, dans chaque cas, des points qui empêchent leur homologation complète par Agriculture Canada;

6. Recueillir, de chaque province, des statistiques (présentation normalisée établie par le gouvernement fédéral et approuvée par les provinces) sur l'usage de pesticides dans les forêts (épandage au sol et aérien);

7. Discuter de questions précises de lutte antiparasitaire et présenter des recommandations dans un sommaire.

4.0 Composition:

Le point n° 7 de la section 3.0 représente une grande modification des activités du Forum. Il faudra charger un comité directeur de rédiger des énoncés des questions dont les participants au Forum se serviront pour en discuter ouvertement, avant de passer au vote. Les motions adoptées deviendront les recommandations du sommaire que les participants pourront ensuite utiliser à leur gré.

4.1 MEMBRES DU COMITÉ DIRECTEUR:

Représentants des services forestiers provinciaux: - 1 par province (10)

Représentants du Service canadien des forêts:
- 1 par institut (2)
- 1 par bureau régional (6)
- 2 de l'administration centrale

Secrétaire de direction: - RIMA - adminstration centrale du SCF

5.0 Participants invités:

Pourront participer au Forum:

- les préposés à la lutte antiparasitaire au palier provincial
- les fonctionnaires fédéraux et provinciaux (santé, faune et flore, pêches et océans, environnement)
- le personnel chargé de la lutte antiparasitaire au gouvernement américain et dans les États avoisinants
- les préposés fédéraux aux relevés, à la recherche et à la réglementation des pesticides
- les représentants de l'industrie forestière (sociétés individuelles et regroupées)
- les chercheurs:
  - des gouvernements provinciaux,
  - des laboratoires privés de recherche,
  - des établissements post-secondaires
- d'autres personnes, comme approuvé par les membres votants (par ex.: représentants du Conseil de la tordeuse des bourgeons de l'épinette, experts-conseils en foresterie).

N'y seront pas conviés:

- les médias,
- les groupes écologiques,
- l'industries des pesticides.

6.0 Produits:

6.1 RAPPORT ANNUEL:

Le Forum permet l'échange de renseignements. Par conséquent, on continuera de produire un rapport annuel qui contiendra les exposés écrits détaillés des intervenants, leur nom et leur adresse et un sommaire incluant des recommandations (voir ci-dessous). Chaque membre du comité directeur en recevra deux copies (une cataloguée pour la bibliothèque, une pour son usage personnel); tous les autres participants en recevront une: les invités absents (voir liste, section 5.0) en recevront une également, s'ils en font la demande par écrit.

6.2 SOMMAIRE:

Un sommaire (2-3 pages) sera rédigé chaque année par le comité directeur et donnera en bref la répartition des insectes et des maladies, les programmes en cours et proposés de lutte antiparasitaire ainsi qu'un énoncé des questions et des recommandations. Il sera remis aux participants et inclus dans le rapport annuel.

7.0 Fonctionnement:

Le Forum sera présidé conjointement aux paliers fédéral et provincial (voir section 8.0).

8.0 Ordre du jour:

Pour le rapport annuel, il faut des exposés détaillés des programmes et de la recherche en matière de lutte antiparasitaire. Toutefois, l'ordre du jour sera rationalisé pour allouer plus de temps aux discussions. Le Forum continuera à durer trois jours (exposés et ateliers), mais on consacrera une demi-journée aux comptes-rendus sur la lutte antiparasitaire opérationnelle, une demi-journée à la recherche, à la surveillance environnementale et aux questions de santé ainsi qu'une demi-journée aux discussions et à la préparation des recommandations. Vu ce calendrier très chargé, les exposés devront être à propos et brefs, donner les grandes lignes et souligner des points de discussion, pour la période prévue à cette fin.

L'ordre du jour sera établi par le secrétaire de direction, de concert avec le représentant provincial et celui du bureau correspondant du SCF, soit le ministère des Ressources naturelles de l'Ontario et le Centre de foresterie des Grands-lacs, en 1987. Évidemment, certains bureaux du SCF regroupent plusieurs provinces; par conséquent, on y aura probablement recours plus souvent. Les responsables provisoires des forums à venir sont donc les suivants.

ANNÉE	ORGANISATEUR	SCF
1	Ontario	Sault Ste-Marie
2	Colombie-Britannique	Victoria
3	Québec	Québec
4	Alberta	Edmonton
5	Nouveau-Brunswick/ Ile-du-Prince-Édouard	Frédéricton
6	Saskatchewan	Edmonton
7	Nouvelle-Écosse	Frédéricton
8	Manitoba	Edmonton
9	Terre-Neuve	St. Jean

9.0 Lieu:

Le Forum se déroulera encore à Ottawa en 1987 et en 1988, mais on envisagera sérieusement de le tenir dans d'autres provinces, tous les ans, à compter de 1989.

10.0 Dates:

Elles devraient continuer à tomber durant la troisième semaine de novembre.

11.0 Budget:

Le Forum continuera à se tenir sous les auspices du Services canadien des forêts, et les frais accessoires (par ex.: affranchissement, publicastion de comptes-rendus des rencontres, salle de réunion) seront supportés par le gouvernement fédéral.